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ABSTRACT

A study compared the perceptions of the social environment of satisfied women engineering students against dissatisfied students and ex-students at twelve engineering schools with varying percentages of female students. The results found no direct effects of the perceived or actual porportion of female enrollment on satisfaction with engineering. In fact, the proportion of females did not directly affect performance (grades), feelings of social ambiguity and isolation, or perceived support from institutional personnel. The proportion of females in the environment was strongly related to peer group interactions, especially intimate interactions in which personal problems were discussed with a confidant. Relations among the percentage of women, presence of a confidant, feelings of social integration, and satisfaction with engineering were observed. Throughout the analysis, the perceived support from the male peer group was more consistently and strongly related to all measures of satisfaction. The findings, which suggest the inseparability between grades and social satisfaction, the importance of the dominant male peer group and the family, and the perception of alternative social situations, are related to four theories: critical mass, tokenism, social fit, and individual environment fit. (Author/BM)

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Final Report

CRITICAL MASS AND SOCIAL SUPPORT FOR WOMEN CHOOSING NONTRADITIONAL CAREERS

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ABSTRACT

The study compared the perceptions of the social environment of satisfied women engineering students against dissatisfied students and ex-students at 12 engineering schools with varying percentages of female students. The results found no direct effects of the perceived or actual proportion of female enrollment on satisfaction with engineering. In fact, the proportion of females did not directly affect performance (grades), feelings of social ambiguity and isolation, or perceived support from institutional personnel.

The proportion of females in the environment was strongly related to peer group interactions, especially intimate interactions in which personal problems were discussed with a confidant. Relations among the percentage of women, presence of a confidant, feelings of social integration, and satisfaction with engineering were observed. Throughout the analysis, the perceived support from the male peer group was more consistently and strongly related to all measures of satisfaction.

The findings suggesting the inseparability between grades and social satisfaction, the importance of the dominant male peer group and the family, and the perception of alternative social situations were related to four related theories. Two of these theories, critical mass and tokenism, address the direct effects of the structure of the environment on the individual. Two other theories, social support and individual-environment fit, emphasize the interplay between the individual and the social and structural aspects of the environment. In general, the current data better fit the frameworks focusing on the complex interactions within the environment, but none of these four social theories account for the strong influence of the comparisons made regarding social alternatives.

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EXECUTIVE SUMMARY

Occupational segregation is perpetuated by the existing problems in attracting and keeping women in nontraditional areas of education and training. It should be possible to determine the factors that lead to dissatisfaction and/or dropping out in nontraditional areas. With this information, intervention programs can be designed and implemented to change the situation.

One theory that has been proposed as a potential remedy for the lack of women in nontraditional fields is critical mass. Critical mass theory assumes that once there is a certain percentage of women in a particular nontraditional environment, they will provide support for each other and a series of institutional changes will occur. (This proportion is thought to be from 15 to 20 percent.)

The theory of critical mass was tested in this study by surveying female engineering students at nine engineering schools with percentages of women ranging from 5 to 19. Dropouts and current enrollees were compared on their perceptions of available social support and their satisfaction in the nontraditional setting of engineering school.

According to critical mass theory, there should be a relationship between the percentage of female students and the extent of institutional support and feelings of social isolation. However, no such direct relationship was found. Kanter's work on tokenism suggests a relationship between percentage of female students and their performance. Again, no such direct relationship was found.

This study found the only direct relationship of critical mass was having a peer confidant or close friend at the school. (It is interesting to note that this close friend was male as often as female.) Having a close friend was directly related to feelings of acceptance; without this person there were frequently feelings of social isolation, and social isolation was a primary factor directly related to dropping out. Thus, critical mass was related to the existence of a close friend, which in turn was related to feelings of acceptance, which in turn was related to remaining in and satisfaction with engineering.

This study identified critical mass as a starting point rather than a solution. Future research can proceed to develop the complex models needed to examine the interrelationship of factors affecting attraction to and retention of women in such nontraditional fields as engineering.

Because the results of this study are complex and may be of interest to a diversified audience, a nontechnical synopsis is included at the beginning of each chapter. This is followed by background information and results except in Chapter I, which is subdivided into purpose, methodology, and analysis, and Chapter VII on discussion and implications of the study.

I. THE STUDY

Synopsis

How important is social support for women in a nontraditional field such as engineering? What role does social support play in women remaining in that field? Do sheer numbers (critical mass) of women provide whatever support is needed?

It has been assumed that critical mass is a major factor for retention of women in nontraditional fields. In fact, there is little evidence or data to prove or disprove this.

This study examined these issues and, perhaps, raises more questions than it answered. It can, however, serve as a starting point and a catalyst for assembling and analyzing data about both critical mass and the importance of social support for women in nontraditional environments.

Both dropouts and women currently enrolled in nine engineering schools were surveyed. They were asked questions that reflected their perceptions about the role and importance of social support.

Purpose

This study was funded by NIE Grant G-78-0140 as one of a series of grants to examine approaches to achieve educational equity for women.

Educational inequity is a subtle and complex process, contributed to by all the participants in the educational system. Perhaps the most deleterious result of educational inequity is occupational segregation. Occupational segregation in turn, directly and indirectly, affects the labor force and unemployment, salaries and benefits, as well as realization of personal potential and the productive contribution of women.

One of the symptoms of educational inequity is the failure to attract women to nontraditional fields and the failure to retain women in these fields. And one of the major barriers to educational equity for women may be the absence of social support for those women choosing nontraditional fields of study.

There is a growing body of evidence that suggests that individuals suffer detrimental consequences if social support is not available to them, especially when they are under stress, such as being a minority in a nontraditional environment.

Studies such as this one can suggest directions for school administrators and policy makers for meeting the needs of the women they seek to attract and retain in nontraditional areas of study. It is possible

that social support interventions can increase retention of women in nontraditional careers and that the impact on occupational segregation may be fast and dramatic.

Methodology

There are acknowledged problems in attracting and keeping women in nontraditional fields such as engineering. It should be possible to determine the factors that affect dissatisfaction and/or dropping out. Once these are known, the hope is that programs will be developed and implemented to reduce the presence or intensity of these variables.

The study of social support and educational equity was originally designed to directly test the notion of "critical mass" as a factor in retention of women in nontraditional fields (engineering) and to generate hypotheses regarding the role and function of social support in educational environments. Due to the unavailability of attrition records of women in individual schools, no conclusive empirical study of critical mass could be designed with the allocated budget (see Appendix B for details). Consequently, the perceived effects of social support were studied by surveying both dropouts and currently enrolled female students in engineering schools with different proportions of female students.

The design of the study focused on a comparison of the social support perceived to be available to women at schools with varying percentages of female students. The study, then, concentrated on the relationship between social factors and dissatisfaction in nontraditional settings for women. These comparisons, obtained by a survey, suffered from several severe limitations. First, as discussed below, the study encountered extreme difficulty in obtaining the names and current addresses of female dropouts, an already small sample. Therefore, several measures, such as current satisfaction, were used as indicators of a possible decision to drop out in some of the analyses.

Second, the limitations of the budget made it impossible to obtain a comparison sample of male students. Third, we had no means of external validations of the female students of social support. Although we had intended to utilize the background institutional data gathered by Connolly and Porter (1978), the study sampled only schools which, by and large, have been supportive of efforts to increase the number of women in engineering because of the extremely small numbers in the other schools.

A fourth limitation on the interpretation of the data is that the design precluded obtaining baseline information on the students at the time of entry into engineering. This information, especially on social competence and social patterns, might have clarified some of the results. And, by necessity, the data from the dropouts was retrospective; e.g., they completed the questionnaire as they had felt when they dropped out of engineering, a time lag of as much as a year.

Finally, the study was hampered by the absence of clear definitions of social support, its functions, parameters, and interactions in any setting, and the paucity of well-designed empirical studies of the social support factors in educational settings. Because of these limitations, the study and its results should be considered exploratory and suggestive, rather than conclusive.

Based on a review of several bodies of literature, the factors hypothesized to influence dissatisfaction and a decision to drop out are shown in Figure 1.1. These factors guided the design of the questionnaire and analysis.

The student sample was obtained by contacting 12 engineering schools that had been used in previous studies, which supplied background information and material for comparative interpretation. These studies were by Ott (1978) and Connolly (1979).

A letter explaining the study and the assistance required of each of the schools was sent to the Dean of Engineering. The letter requested the names of a sample of their present female engineering students and a sample of females who had dropped out of the program. The initial response was unanimous and enthusiastic; however, after some checking, three schools found they were unable to participate due to restrictive state laws governing disclosure of student names and records, leaving nine schools to participate in the survey.

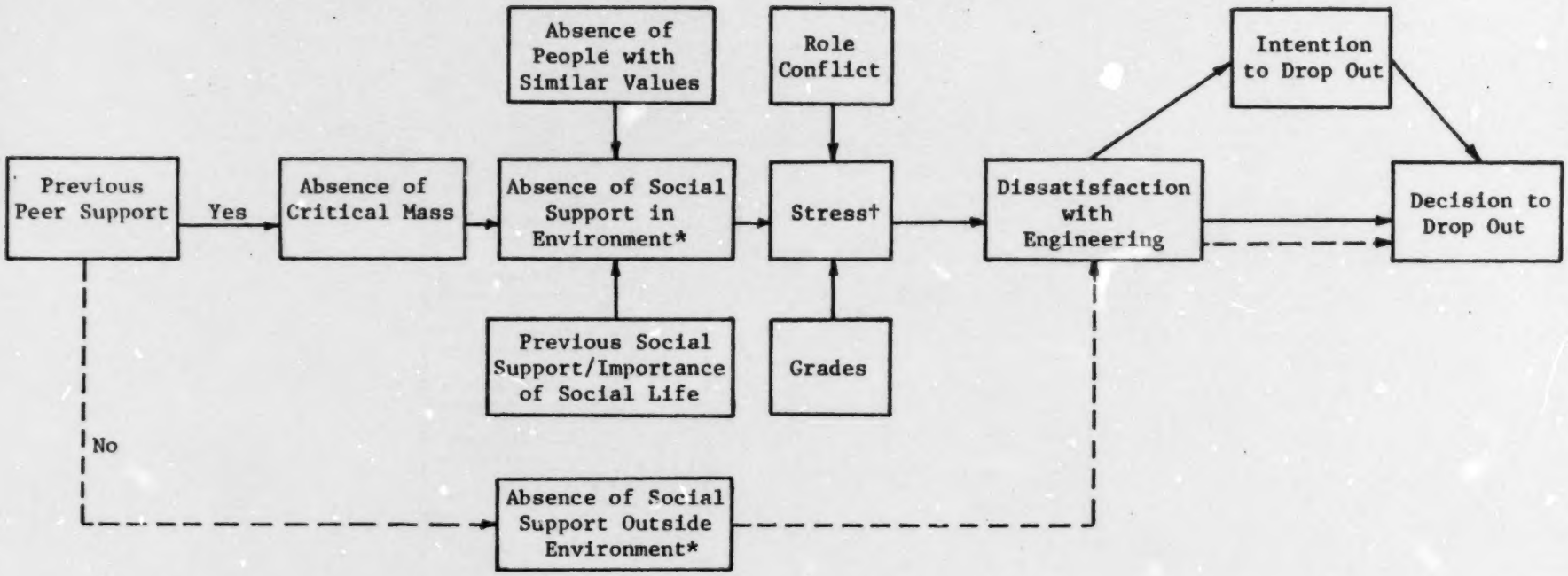
Each school compiled names and addresses, with some mailing the questionnaires directly and some providing the names to DRI for mailing. Each student was sent a letter, enclosed with the questionnaire, explaining the purpose of the study, the manner in which their names were obtained, and an assurance of response confidentiality. A stamped, self-addressed envelope was also enclosed for returning the completed questionnaire.

The questionnaires were reviewed by Drs. Ott and Connolly and pretested by nine freshman engineering students who were not included in the sample from the Colorado School of Mines.

The participating schools and student samples from each school are shown in Table 1.1. About a third of the samples came from schools with a relatively high percentage of female students (averaging around 15 percent), another third came from schools with a relatively low percentage (averaging around 7 percent), with a final third from the middle range. Although an attempt was made to obtain equal samples of current students and dropouts, the ratio in the final sample was 681 retained students (70 percent) to 286 dropouts (30 percent).

Analysis

The overall response rate was 39 percent. There was a substantially different response rate by school (3 to 46 percent) and by enrollment status (13 percent for the dropouts and 48 percent of current enrollees). To check for possible biases resulting from the low response



*As measured by: number of confidants
frequency of support
time spent with supports
functions
type of support

†Not specifically measured but inferred by grades and role conflict.

Figure 1.1. Factors Hypothesized to Influence Satisfaction in Nontraditional Careers

TABLE 1.1. PARTICIPATING SCHOOLS AND STUDENT SAMPLES

School	Percentage of Women in School	Sample of Attendees	Responses	Sample of Dropouts	Responses	Total Responses
Carnegie-Mellon University	18.8	70	28	30	0	28
Colorado School of Mines	14.0	120	64	50	12	76
Lehigh University	12.5	202	96	35	12	108
Cornell University	12.5	70	29	50	2	31
University of Wisconsin-Milwaukee	8.5	70	16	30	1	17
Drexel University	8.0	20	3	10	0	3
Texas Tech	7.0	50	47	50	2	49
University of Lowell	6.7	50	14	10	1	15
Northeastern University	6.5	29	13	21	1	14
Source Unknown			20		6	26
TOTAL		681	330	281	37	367
% Responses			48		13	38

rate, a complete check for school differences was run. No significant differences by school were observed for grades, perceived institutional support, or by feelings of role ambiguity and social isolation.* It was concluded that the nonresponse bias (represented by the different response rates by school) did not dramatically influence the results and that the survey results are generalizable to the population under examination.

The design of the analysis was based on an attempt to both test and generate hypotheses regarding the impact of the social environment. Therefore, not only were the initial hypotheses carefully examined, but additional hypotheses stimulated during the data analysis were investigated by the following methodologies.

- Frequency analysis of the responses to the individual items was run.
- Cross tabulation of items examined relationships between nominal and ordinal level variables and investigated bivariable relationships.
- Factor analysis and correlation analysis identified and classified related items or groupings of items.
- Discriminant analysis identified variables which discriminate between satisfied and dissatisfied students.
- Cluster analysis identified patterns of responses (people) that might indicate categories of utilization of support resources.

The various analyses were performed on slightly different composites of the variables since some conceptual and empirical difficulties were encountered in the development of scales and because of the absence of previous work in this area. When the results of the analysis concurred significantly, despite the different composites and methods of analysis, the findings were considered to be reliable. The results of the analyses are presented in detail in Appendix A.

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*Separate reports on the differences among schools are available.

II. CRITICAL MASS AND SOCIAL SUPPORT

Synopsis

A theory has developed in education that once a certain percentage (critical mass) of a minority population is reached within a larger group, the minority group will become self-sustaining and self-perpetuating. The critical mass percentage is thought to be between 15 and 20 percent. The problem with this theory is that while it has been assumed to be true, it has never been fully examined.

Recently, some studies have looked at aspects of critical mass: Ott (1978), Gordon and Pipkin (1978), Connolly (1979), as well as Kanter (1976) who developed a theory on tokenism similar to critical mass.

In keeping with critical mass theory, there should be a relationship between the percentage of female students and the extent of institutional support and feelings of social isolation. However, no such direct relationship was found. Kanter's work on tokenism suggests a relationship between percentage of female students and their performance. Again, no such direct relationship was found.

This study found the only direct relationship of critical mass was to having a peer confidant or close friend at the school. (It is interesting to note that this close friend was male as often as female.) Having a close friend was directly related to feelings of acceptance; without this person there were feelings of social isolation, and social isolation was a factor directly related to dropping out. Thus, critical mass affects the existence of a close friend, who in turn affects the feelings of acceptance, which in turn affects remaining in school and satisfaction with engineering.

Critical mass alone is not enough. Rather, it may be a precondition for a chain reaction that leads to retention and satisfaction of minority persons in nontraditional areas. The relationship of all these factors to specific environments needs to be examined in future studies so that positive programs can be developed and implemented to attract and keep minority groups in nontraditional environments, such as women in engineering school.

Background Information

In educational circles, critical mass has become a catchword. Although a complete and systematic theory has not been developed, the concept of critical mass postulates that once a certain proportion or number (mass) of the population is present, recruitment and retention of that population becomes a self-sustaining and self-perpetuating system. This presumably occurs because of the increased availability of social

support from other similar individuals and greater congruence between the institutions and the population. This mass had typically been assumed to be between 15 percent and 20 percent (see, for example, Connolly, 1979; Burkes, n.d.).

Inferences about the construct of critical mass may be made from the contexts in which it has been used. These inferences involve a series of related sequential assumptions regarding the self-perpetuating nature of institutional change. These assumptions are:

- The greater the amount of support and encouragement perceived by members of a minority population, the greater the likelihood they will stay in the environment; e.g., they feel less alienated and more content.

- The greater the number of people who are content in their environment, the greater the likelihood that they will remain in the environment (the retention rate increases).

- The greater the number of that population who remain in the environment, the greater the number who will be attracted to it, e.g., recruiting is less difficult because:

  - The population perceives they will be happy in that environment because others they perceive as similar have stayed in it.

  - More persons actually know people who are part of that environment.

- The greater the number of the minority population, the greater the likelihood of increasing their representation in leadership positions.

- The greater the number of the minority population represented in leadership positions, the greater the amount of support and encouragement given to the other members of the minority population.

- The greater the support and encouragement received by members of the minority population, the greater the likelihood they will stay in the environment.*

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*It is not clear whether the end point of this circular process is acceptance and assimilation into the mainstream of the dominant culture, or whether it is a segregational power block.

It has been postulated that once a critical mass of minorities/women participates in a previously nontraditional activity, no further need for special recruiting/retention programs will exist. In fact, an ever-increasing rate of participation may result. Conversely, the absence of the critical mass may produce a situation where efforts must be continuously expended to recruit and retain these groups, since the history of unsuccessful participation acts as a discouraging factor, e.g., as more drop out of the system because of a feeling of isolation, fewer will be attracted.

The concept is primarily speculative. Only recently has it received any empirical support. Connolly and Porter (1978) conducted an analysis of enrollment patterns of 289 engineering schools for the years 1972-1976.* He found that for all sizes of schools, the freshman class was more heavily female than the school as a whole, but the gap was much smaller for schools having a greater total proportion of women, e.g., "one of the most helpful factors in attracting women is to have a sizable number already." In addition, they found that schools with above average enrollments of blacks did better in attracting women, and schools with a small proportion of female students tended to have fewer female faculty.

Connolly and Porter (1978) compared the ten schools with the most success and the least success in and supportiveness of efforts to increase the number of women in engineering. In general, certain types of schools were characterized by a larger than average percentage of female students (e.g., large and/or elite schools having extensive recruiting efforts). They found no clear and consistent relationship between activities designed for women, although, in general, schools with more women had more activities designed for women, but the findings were largely confounded by size of school.

A study by Ott (1978) of the characteristics of women in engineering found a nonsignificant positive relationship between the retention rates of women and the enrollment of women in the school. She found that the relationship between retention rate and <u>percentage</u> of women ($r = +.35$) was stronger than the relationship between retention and <u>number</u> of women ($r = +.17$).** In addition, on the basis of interview data, she concluded that same-sex peer support was very important and suggested increasing the percentage of women as a mechanism to increase retention.

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*That study also encountered serious difficulty in obtaining reliable data.

**It should be noted that the number of schools used in the analysis was relatively small ($n = 16$), and significance might have been obtained if the number were larger.

The concept of critical mass, if valid, would have important policy implications. For example, many programs are attempting to integrate women/minorities into the social system by a shotgun approach--one here, a few there. The theory of critical mass, however, would suggest concentration efforts on a single school, a single discipline, or a specific workplace for a period of time until the critical mass is reached.

If the concept of critical mass is valid for women in educational institutions, it seems likely it would be valid in many different settings and with many different minority groups. Specifically, it may apply to minority populations in any situation, such as educational institutions, jobs in both the public and private sectors, groupings as small as a math department in one school to as large as the engineering profession, and any group which is a minority within a particular setting.

A theory very similar to critical mass has been offered by Rosabeth Kanter in her work on men and women in corporations. Kanter (1976) postulated that one important determinant of women's achievement is contextual--the significant factor being the sex ratio of the work group. Kanter's point is that the proportion of minority group members in a particular setting significantly affects group dynamics, which will eventually affect individual achievement.

Kanter lists four typologies of group composition:

- Uniform groups - consisting of "only one kind of person, one significant social type" (1976, p. 966).

- Skewed groups - composed of a minority/majority ratio of approximately 15:85. Here minority group members are perceived less as individuals than as tokens. Token status contains three conditions which can generate responses detrimental to the minority member's performance. First, token persons are highly visible. They perform under conditions of no privacy, are over-observed, and have fewer backstage areas than dominant persons. This visibility generates disproportionate performance pressure. Second, the presence of tokens leads to polarization within the larger group. Those characteristics which distinguish the token persons from dominant members come to be perceived as highly salient, even if they are irrelevant to task performance. Third, the individual characteristics of token persons are distorted or misperceived to bring into line with stereotypes about the token's group. This superimposition of stereotypes onto individuals leads to role entrapment. The only behavior which is accepted from tokens is that which conforms to the stereotype.

- Tilted groups - composed of a minority/majority ratio of about 35:65. Kanter hypothesized that the dynamics here are similar to those in a skewed group, but to a lesser

extent. Minority performance will be more like that of majority members, and majority members will be more sensitive to differences in ability and motivation among individual minority members.

- Balanced groups - consisting of roughly equal numbers of all the social types present in the group.

Gordon and Pipkin (1978) assumed that a school environment should have the same characteristics as a corporate setting and tested three specific hypotheses derived from this theory. They compared the performance of female students at a law school with few women (skewed group) with that of women at a law school where there was a larger proportion of female students (tilted group). The hypotheses were that women in the setting with fewer female colleagues would: (1) do less well academically (performance pressure); (2) be less integrated into the law school (social isolation); and (3) be more likely to demonstrate traditional female preferences in study strategies and career choices (role entrapment). The study generally supported these hypotheses but found a disproportionate amount of women at both extremes of peer group isolation/integration when the school had a small proportion of women.

Both the theories of critical mass and tokenism emphasize the impact of the social structure of the environment on the individual. In general, the primary difference between the two theories is that the role of same-sex peer is emphasized in critical mass, while the reactions to the opposite-sex (dominant) peers are highlighted in Kanter's work on tokenism. It should also be noted that the ratio on Kanter's skewed groups is approximately the same as the upper limit in the critical mass construct.

This study examined the effect of sex ratios on social support and tested the following hypotheses:

1. The higher the proportion of women in the engineering school, the greater the proportion of women reporting positive social support within the school.

2. Aggregating arrangements such as group housing will increase the perceived proportion of women on campus and will increase the number of women in that arrangement reporting positive social support.

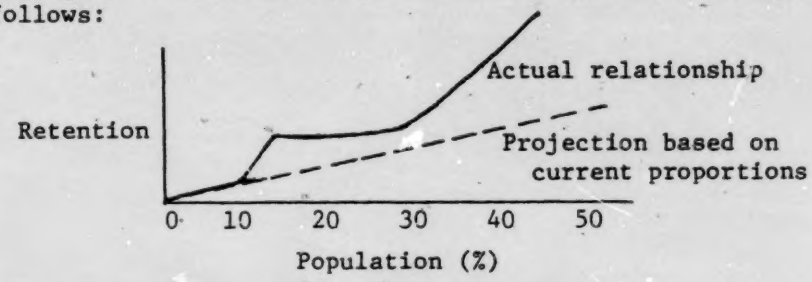
Results

The results found no conclusive evidence for any direct systematic effects of critical mass. Although the percentage of women in engineering was accurately perceived, critical mass was <u>not</u> directly related to feelings of social ambiguity and isolation, institutional support, or satisfaction with engineering.

A positive relationship between critical mass and peer group relationships was found. Critical mass showed a strong relationship to the frequency with which personal problems were discussed with engineering peers. A low frequency of these personal interactions was related to feelings of deviance and isolation which, in turn, were related to satisfaction. A low critical mass → lack of peer confidant → social isolation → dissatisfaction chain was found. Thus, the effect of critical mass on the predicted variables was indirect and mediated by peer group relationships. Perceptions of low critical mass were correlated with participation in formal orgnaizations, where perceptions of higher critical mass were related to close friendships and interactions.

Within this study's restricted range of critical mass (6 to 19 percent), little evidence was found for increased support from other women as a function of the percentage of women. In fact, the most consistent finding was the relative unimportance of a generalized female peer group in engineering on satisfaction; the percentage of women was not reflected in the amount of perceived support from other women in engineering. Small, indirect effects of other women in engineering on the student's perception of herself were found, e.g., feeling different, unfeminine, and unsure of expectations were negatively correlated with the percentage of women in the environment, as was the presence of a close confidant.

Several interpretations may be made of the failure to find compelling evidence for the theory of critical mass. First are the methodology problems of a restricted range of percentages of women and small sample sizes. Second, a rather reasonable alternative explanation, is that current enrollments of women do not allow one to study what happens when critical mass in numbers of women students is achieved. There were no programs in which female enrollments exceeded 20 percent by any sizable margin. Consequently, the actual function of critical mass may be as follows:



That is, the restricted range of sex ratios now prevailing in engineering programs does not provide an adequate basis for describing the full relationship between sex ratio and performance or retention. The low proportions of women currently in engineering programs do not provide for accurate projection of a more equal sex ratio. The curve may be a step function, not a linear one, and the current study tapped a plateau level. A third interpretation of the failure to find any significant

effects of critical mass may he found in the social support literature. Cassel (1974) identified two mechanisms by which social support buffers against stress. The first is that it provides some reservoir of previous experience with the milieu and its expectations, and the second is the mere presence of another "animal of the same species." Cassel's evidence for the second factor is weak and derived primarily from infra-human studies. The first factor, however, seems relevant. Very little relationship between critical mass and social support was found. Perhaps this is because other women students in the same classes cannot offer much of a reservoir of previous experience and appropriate expectations. More women professors and teacher assistants who have made it in the face of obstacles and who have had the relevant experiences would seem to be a better source. However, there are not sufficient numbers of such women at this time to prove or disprove this surmise. In sum, the findings may have resulted from a focus on critical mass of students rather than critical mass of faculty.

Since it was impossible to truly test theories of critical mass given the restricted range, the effects of aggregating women were also examined. No effects of aggregating arrangements (see Appendix A) were found in either perceived critical mass or perceived social support. In fact, women living off campus perceived a significantly larger proportion of women in the school. A higher percentage of women dissatisfied with engineering lived on campus (73 percent) than those women who intended to remain in engineering (57 percent). Aggregating arrangements also appeared to be unrelated to feelings of social ambiguity or satisfaction with engineering.

Implicit in the theory of critical mass is the assumption that women are alike, and, if massed together, they will all help each other. This assumption has not been entirely borne out in the experience of the women's movement and is refuted by the past decade of research on sex and personality differences which indicates that differences are greater between people than sexes. The data indicated that the dominant environment--in this case, a male-oriented one--sets the tone for the "fit" of the women students. Observations made on the basis of the survey comments, and the results of the cluster analysis (Chapter 6) indicated that the women are not homogeneous in their need for and utilization of social support.

III. SOURCES OF SOCIAL SUPPORT

Synopsis

The confusion and/or stress in certain situations that result from an individual being in the minority can be lessened by supportive contact with another individual. This individual has never been clearly defined in the theory of social support. He/she may be part of the same minority group or outside it, a personal friend or relative, or a professional counselor or teacher. In short, it could be anyone who, for whatever reason, is paying attention to the needs of the individual under stress. This is called social support. The theory of critical mass, however, assumes this person would be a peer of the same minority group within the same larger group.

A theory similar to social support called the "fit" theory has recently been proposed. It argues that the closer a minority student's values, goals, and attitudes are to those of the school, the more likely he/she will remain in school. This "fit" implies that there are increased opportunities for forming close personal contacts, and social isolation is less likely.

This study looked at the types, existence, and relationships of sources of social support for female engineering students. The family, male or female close friends within the school, and school personnel were identified as important as sources of social support for the women who remained in engineering.

There was a relationship among the different sources of social support and some generalizations occurred by age group and environment.

Background Information

Although the term "social support" has become part of everyday jargon, the term has its roots in theories of the effect of the environment on individual health and well-being. In fact, recent evidence has suggested that stress and psychosocial processes may enhance an individual's susceptibility to a wide variety of physical and mental disorders. Cassel (1974) commented that a remarkably similar set of social circumstances characterize people who develop a wide range of disorders, from tuberculosis to alcoholism. Common to all of these people is their marginal status in society. They are individuals who, for a variety of reasons (such as ethnic minorities rejected by the dominant majority in their neighborhood or in isolated living arrangements), have been deprived of meaningful social contact (p. 456). Implicit in these theories is the assumption that marginal social status is a form of stress. In addition, Cassel stated that stress may also be encountered when individuals are unfamiliar with the expectations of their environment or when they have role conflict or status inconsistency.

There appear to be two mechanisms that may protect the individual from the consequences of a confusing or stressful environment. The first is previous experience with the milieu and its expectations, and the other is the presence of another "animal of the same species" in the stressful environment (Cassel, 1974, p. 478). These groups of significant others that protect or buffer an individual from the consequences of stress have come to be termed social support groups.

A large number of studies have examined the reasons women don't pursue nontraditional careers in general and science or engineering careers in particular (see Lantz, West, and Elliott, 1977, for a review). Many of the studies have enumerated theories similar to social support for avoidance and attrition and emphasize the importance of encouragement and support from important significant others. For example, lack of support from teachers and male peers have been given as reasons why young women do not pursue nontraditional careers (see, for example, Ernest, 1967; Haven, 1971; Luchins, 1976; Entwisle and Greenberger, 1972; Rossi, 1975; Prediger, McLure, and Noeth, 1976; Smith, 1976; Farley, 1974).

The same principles of absence of social support may explain the body of evidence on female dropouts from the educational system, especially those with nontraditional goals. A review of the characteristics of dropouts portrays a student who is marginal to the social/academic setting (e.g., Pantage and Creedon, 1978). This hypothesis has been confirmed by Noel (1975) who found that of the four major reasons for attrition, isolation was the most important, followed by dissonance, boredom, and financial difficulties.

Tinto (1975) proposed a model of the attrition process which postulates that when both social and academic integration of the student occur, the probability of attrition decreases. In the case of the woman pursuing a nontraditional endeavor, the paths of social and academic integration may be more or less mutually exclusive; if she has goal commitment, grade performance, and academic integration, she may be less likely to be socially integrated because she is not conforming to conventional feminine stereotypes.

Pascarella and Terenzini (1979) tested Tinto's model of academic and social integration in a liberal arts college and examined the interactions between original student characteristics and student experiences. They found modest support for the suggestion that high levels of social integration could compensate for low levels of academic integration and vice versa, as well as the compensatory nature of certain college experiences with characteristics of entering students. As interesting, however, was the failure of the set of entering characteristics to make a significant contribution to predicting the future withdrawal of a student. They concluded that relationships with the faculty were among the most important of these on-campus experiences. It should be noted, however, that Feldman and Newcomb (1969) came to the opposite conclusion by suggesting a minimal impact of faculty and a large influence of the peer group.

Recently a "fit" theory similar to the Tinto model has been proposed to account for the findings in attrition (e.g., Astin, 1964; Barger and Hall, 1964; Farwell, Warren, and McConnel, 1962; Previn, 1968; Savicki, et al., 1970). The "fit" hypotheses state that the more congruence there is between the student's values, goals, and attitudes and those of the college, the more likely it is that he/she will persist at that college.

In actuality, the "fit" theory is very similar to a theory of social support. Congruence between the values of the college and of the student implies that the institution and its members implicitly and explicitly approve of and provide support for the student's orientation. As Starr, et al. (1972) have put it, congruence between the student and the institution will enable him/her to meet the academic and social requirements of the institution and thus receive its rewards.

Beyond the "generalized other" approval available when congruence is present, congruence between the student and the institution increases the probability of forming close personal contacts and receiving peer group support. Specifically, the number of similar students with similar interests and values is larger when student/school congruence is present for any individual; hence, there is a greater probability of forming close personal ties for any given "congruent" student, since people are attracted to individuals they perceive as similar (Middlebrook, 1974). In sum, social isolation is less likely when congruence is present.

Both the individual-environment fit and the social support hypotheses focus on the interactions between the individual and the environment. Previn (1968) has emphasized the interdependence and reciprocality of these interactions. Thus, the concepts of cause and effect are inappropriate concepts in this framework. In general, social support has been viewed as less dynamic and is often presumed to buffer an individual from the environment, rather than being a part of that environment continually in flux.

As compared to theories of social support and individual/environment congruence, critical mass and tokenism emphasize structural rather than social elements of the environment and presume less complicated interactions among the individuals, their modes of response, the social environment, and the task.

Any of the theories may account for a wide variety of other findings regarding attrition. For example, Darly (1962) found that sex was an important variable in attrition in some institutions but not in others. An illustration of the different institutions is given by Iffert (1957) who reported that retention is greater for women in teacher's colleges (a predominantly female environment). Cope, Pallthorp, Trapp, and Skalung (1971) and Astin (1964) reported that women are more likely to drop out when they are attending institutions with a high male to female ratio. While this has been interpreted that women who want to marry attend institutions with high male-female ratios, it may instead be that they enter an environment where they are subjected to social isolation and are less able to find peer group support.

The present study of retention and satisfaction of women in engineering school was designed to extend the existing theory of social support to educational situations and to examine the relationship of social support to critical mass. It was assumed that pursuit of a nontraditional career confers upon an individual a marginal status that will act as a form of stress. The environment in which she prepares for her nontraditional career may give her mixed, ambiguous, and confusing messages. Being a pioneer, she has little conception of or previous experience with the behaviors expected of her. And, the sheer absence of "other animals of the same species" often makes social support unavailable. Specifically, although aggregation of numbers of individuals (critical mass) who might provide support for each other may not insure that support is available for any particular individual, it may be a necessary precondition for social support to be available.

It was further assumed that many people, when faced with such a stressful situation, would leave the environment if alternatives were available. Although the salience and stress of an event is defined by the individual, and some women may not perceive the situation to be unpleasant, it seems likely that the socio-psychological environment of many women currently in engineering school may be detrimental to their satisfaction with and retention in that environment.

Results

This section of study examines the types, existence, and relationships of sources of social support for female engineering students.

In order to analyze sources of social support, it was necessary to form composite variables. Questions regarding perceived levels of support from key individuals by type of support were examined by computing a correlation matrix on the variables. It was discovered that most respondents distinguished very little among the types of support they received from each individual (see Question 35, Appendix A). However, distinctions between support in conducting instrumental tasks ("helping me get my work done") and emotional tasks ("boosts my spirits when I'm low") seemed conceptually and empirically justified. The categories of emotional and instrumental support, as well as means of total support, were used for the majority of the data analysis.

The support received from each of the significant others was compared to the rank of importance of each of these sources assigned by the female students. As seen in Table 3.1, parents, boyfriends, and female friends were ranked as most important to the female engineering students, while professors and other male friends were ranked lower. The ranking of importance very closely follows the amount of social support received from that source, e.g., it seems possible that the experience of receiving support from a source increases the importance of that source.

Also seen in Table 3.1, although ranked relatively low in terms of overall importance, male friends in engineering and professors were seen as providing a great deal of instrumental support, while female

TABLE 3.1. SOURCES OF SOCIAL SUPPORT

Person / Support (Mean)	Female Friends in Engineering	Male Friends in Engineering	Professors	Other School Personnel	Boyfriend/Spouse	Other Female Friends	Father	Mother	Other Relatives
Instrumental	1.95	1.75	1.55	2.85	1.90	2.55	2.35	2.35	2.90
Emotional	1.60	1.70	2.20	2.40	1.80	2.00	1.30	1.30	1.70
Total Support	1.65	1.70	1.90	2.40	1.75	2.10	1.63	1.63	2.08
Correlation between instrumental and emotional support	.71	.65	.65	.71	.62	.55	.59	.48	.61
Mean rank of importance of source	4	5	7	-	3	4	2	1	6

Scale: 1 = a lot of support, 4 = no support

friends in engineering were perceived as providing the most emotional support in the campus environment. Because analyses showed the relative unimportance of female friends in engineering, it seems that instrumental support may be a more important influence on satisfaction, and assistance in the accomplishment of work is more important than emotional support within a task-oriented environment.

Table 3.1 illustrates several interesting facts about the relationship between emotional and instrumental support and shows them to have a moderately high intercorrelation (around .60). The sources of support within the campus environment have higher intercorrelations between instrumental and emotional support than noncampus (family) sources. This is not surprising. It would be expected that people within the working environment are in a better position to assist on instrumental tasks. Thus, higher intercorrelations between emotional and instrumental support given by any one person would be expected from co-workers, indicating the ability and availability to offer both types of support. It is interesting to note that the highest intercorrelation between emotional and instrumental support is from female friends in engineering and professors.

With the exception of female friends in engineering, the intercorrelation among perceived instrumental and emotional support is lower for women, e.g., other female friends and mothers had the lowest correlation. Examination of the individual items suggests that the low intercorrelation between instrumental and emotional support may reflect the perception of women unable to be helpful in getting the job done.

Table 3.2 gives the intercorrelations among sources on total support and shows that in general all sources of support within a given environment are more correlated to each other more than they are to similar sources in another environment, e.g., there were significant intercorrelations among the sources of support available on campus. Most of the correlations between noncampus sources of support also showed a moderately high intercorrelation.

There were also high intercorrelations between the amount of support received from male and female peers, probably indicating a "generalization" of perception of engineering peers. The same was true of school personnel and professors, but a much lower correlation between peers and institutional personnel was observed.

These correlations indicated that social support is a generalized perception that is influenced to some extent by age and environmental context. It seems then that female students form a generalized perception of the support climate of peers, school personnel, and the family.

A factor analysis was performed to define major sources of support and to provide information regarding their relationship to each other and to satisfaction with engineering school. The factor analysis yielded eight factors, which accounted for approximately 32 percent of the variance. Appendix A shows the items included in each factor. The factors extracted in order of the variance they accounted for were:

TABLE 3.2

	CORRELATIONS AMONG SOURCES OF TOTAL SUPPORT								
	Female Friends in Engineering	Male Friends in Engineering	Professors	Other School Personnel	Boyfriend	Other Female Friends	Father	Mother	Other Relatives
Female Friends in Engineering	--	.49	.28	.27	NS	.23	.16	.18	.20
Male Friends in Engineering		--	.32	.26	.29	.28	.14	.18	.17
Professors			--	.58*	NS	.20	.15	.23	.25
Other School Personnel				--	NS	.25	.21	.25	.34
Boyfriend					--	NS	.26	.21	.19
Other Female Friends						--	.26	.25	.25
Father							--	.64*	.43
Mother								--	.50*
Other Relatives									--

- Deviance/social isolation - This factor indicated someone who is feeling alone, unfeminine, uncertain of other people's expectations, and perceiving other's disapproval of their ambitions.

- Family support - This factor indicated social support and approval from parents and other relatives, although adult school personnel also affected this factor.

- Peer confidant - The frequency of discussing personel problems with someone on campus was tapped in this factor, indicating close and frequent interaction with a male or female engineering peer. This person could also be a boyfriend.

- Dissatisfaction with engineering - This factor measured overall dissatisfaction with engineering as a major and included items indicating current status, intent to change majors, and feelings about whether they would undertake engineering school again knowing what they know today. It also included their grade point average (GPA) and the frequency of academic problems.

- Alternative social life - This factor indicated comparative dissatisfaction with the social life at engineering school, e.g., whether their social life had been better before engineering school or would be better in another school/ department.

- Grades - This factor was a measure of actual grades, grades they expected to make, and the difference between the two.

- Institutional support - This factor was a general measure of the perceived social support received from professors and other school personnel and the amount of help perceived to be available on campus.

- Critical mass - This factor described the proportion of women in the engineering school.

Figure 3.1 presents the factor intercorrelations among the major sources of support: the family, peer confidant(s), and institutional personnel. Support from each of these sources showed a moderate positive correlation, with the greatest correspondence between the presence of peer confidants and family support. This high correlation (.46) suggested that close relationships with family members facilitated close relationships with peers, either as a learning experience or freeing them from stress related to inadequate family interactions.

No strong factor emerged describing "generalized" male and female peer support, although instrumental and emotional support from male and female peers in engineering had high item intercorrelations that were

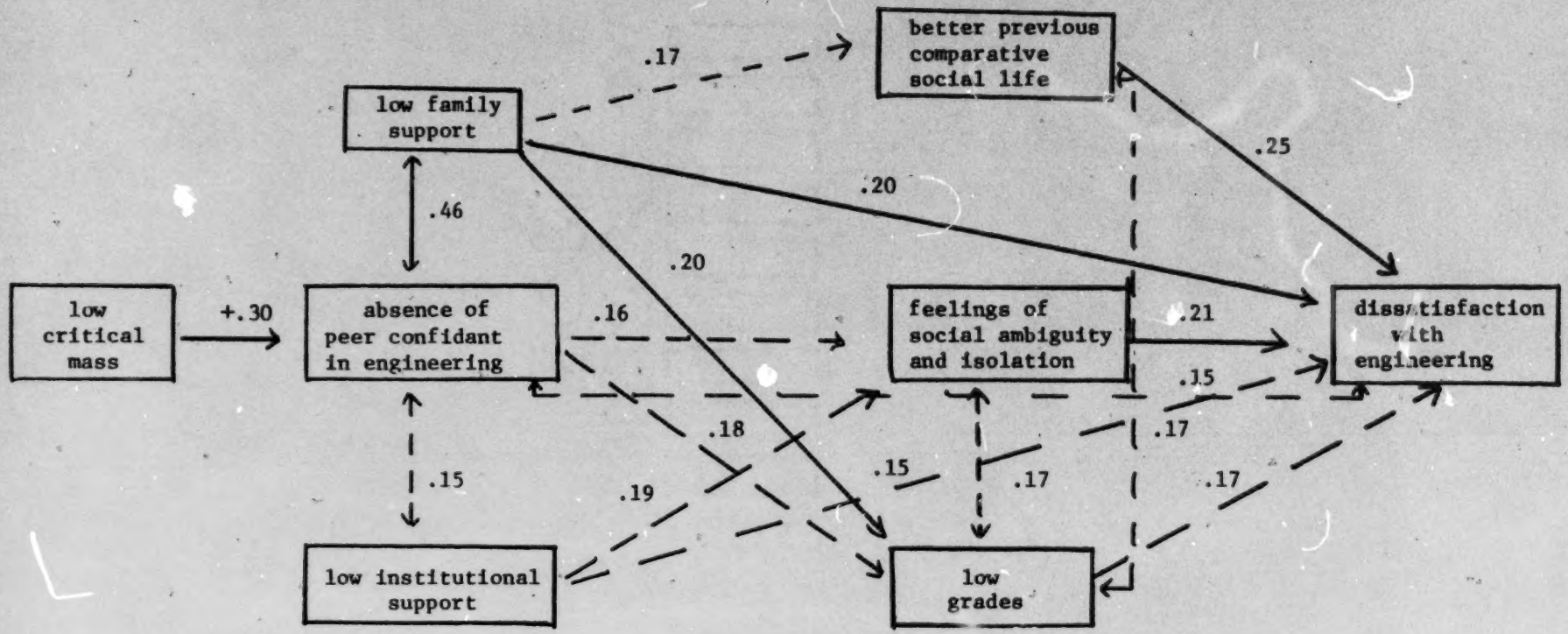


Figure 3.1. Interrelation of Factors

relatively independent of the presence of close confidants. The confidants factor showed that the number of people one could talk to about personal problems on campus was negatively related to the frequency of interactions. The frequency of interactions was related to support from both male and female peers, but the number was only related to male friends. These relationships suggested that a close confidant is more important than the number of acquaintances.

Generally, the relationship appeared to be with a peer confidant and/or peer acquaintances in general and not gender-specific. There was a high intercorrelation between relationships with male and female peers and about half of the confidants were male and half were female. In general, male and female friends showed about the same relationship to other variables in the analysis, indicating that sex of the peer group was not important to the few perceptions they influenced strongly. But female confidants were more closely related to self-perceptions of deviance and isolation. A correlation was observed between feeling as though one had no real friends and female (not male) friends in engineering.

Leisure time activities appeared to fall into two somewhat independent categories: either informal groups (loose friendships or a confidant) or campus organizations. There was a significant negative correlation between the number of leisure hours spent with female friends in engineering and the number of memberships in campus organizations, and a significant negative relationship between perceived number of female engineers and the time spent in campus organizations, e.g., the smaller the perceived percentage of women, the greater the number of hours spent in formal organizational activities, while the greater the number of personal interactions, the fewer hours in organized activities.

IV. SOCIAL SUPPORT AND SATISFACTION IN ENGINEERING

Synopsis

Previous studies suggested a relationship between social support and female students remaining in engineering. This study tested hypotheses relating these two situations and a series of questions was designed accordingly.

The primary response to an open-ended question about the causes of dissatisfaction with engineering was dislike of the content area. But strong correlations between dissatisfaction and lack of social support indicate this also is important, in spite of the direct answer to the open-ended question.

Both grades and social support from a confidant/boyfriend and the faculty/administration were strongly related to satisfaction. The only consistent difference in sources of support between dropouts and current attendees was that current attendees had support from their male peers. Next in importance to them was that they perceived they had support from the faculty/administration.

The number of other female engineering students didn't seem to influence satisfaction. There may still be too few women to make a difference and/or dominant peers are thought to be more important as sources of support for minority groups. It is possible that acceptance by the dominant group in the form of such support is evidence that one belongs and leads to more comfortable feelings.

Background Information

Davis (1977) has argued that one of the reasons that women persist in engineering is because of the support and encouragement they receive from the institution; conversely, without it, they leave. A study by Robinson (1977) suggested the same pattern. In fact, much literature has indicated that this is much more important for women than for men (e.g., Feldman and Newcomb, 1969). Women more frequently reported having their decisions influenced by a peer group or significant others; fewer women felt that professors were helpful; they reported feeling "singled out"; and they had fewer friends who were encouraging. Almost twice as many females as males in the study had sought counseling assistance.

Feldman and Newcomb (1969) have reviewed much of the evidence of the impact of college on the student. In discussion of the attrition process, they note that while seniors at any given school are not necessarily a more homogeneous group than the freshmen at that school, the seniors in a given field or major are more homogeneous than the freshmen. They further argue that original differences in selection on vocational

interests, abilities, and attitudes are accentuated by training, and that defectors or dropouts from a field are "atypical" of those who remain in the field.

Feldman and Newcomb comment that engineering may be the only field where personality differences as well as vocational differences are observed between dropouts and persistors. In a review of the literature (presumably on a male sample), they conclude the following is more true of engineering dropouts:

- Defectors are less stereotyped in thought than those who remain in engineering.
- Transferring engineers are more intellectually oriented and less authoritarian.
- Transfers from engineering have less need to be agreeable and a lower need for "endurance," together with greater needs for social activities, for conversation with the opposite sex, and for autonomy.
- Compared with those who remain in engineering, students who transfer out typically have a lower preference for external structure; are more intensely involved with other people; are more introspective and self-examining; and have a broader and more humanistic and self-expressive set of interests and values.
- Compared to those who remain in fields classified as "realistic" (largely engineering), those who leave are more tolerant of ambiguity, have a more complex outlook, are more original and are less responsible.

These observations on importance of social support to the satisfaction of women in engineering led to the following specific hypotheses:

1. All women being satisfied with or remaining in school will have at least some social support available <u>on campus</u>.
2. The presence of other sources of social support outside of the immediate environment will <u>not</u> substitute for social support inside the environment.
3. Both formal and informal support groups in the immediate environment will influence the decision to drop out of engineering.
4. The absence of peer support will not be defined as stressful if the student has not previously had strong social support.

Results

Several questions were intended to measure general satisfaction with engineering. In addition to the behavioral criterion of already having changed majors, items were included on whether the women were considering changing majors, whether they would make the same decision again, whether they would advise a female friend to go into engineering, and whether engineering school lived up to their expectations. As shown in Table 4.1, which gives the significant item intercorrelation with each of these questions, the questions only showed moderate relationship to each other. For the final analysis, having changed majors or intending to change majors was used as the criterion of dissatisfaction with engineering.

As seen in Table 4.2, the primary reason given in response to an open-ended question for dropping/transferring from engineering was dislike of the content area. This is followed by academic difficulties. Other analyses also indicated the importance of grades. Dropouts expected somewhat lower grades (2.9 vs. 3.1) and, in fact, received them (2.4 vs. 2.9). This confirmed many other studies (e.g., Davis, 1977) who noted that women leave engineering because of discontent with the area or narrowness of the academic content.

Only 4 percent said that the attitudes of the other students were the primary cause for dissatisfaction with engineering. However, Table 4.1 shows strong correlations between dissatisfaction and items regarding comparative social life (e.g., that a different environment would provide them a better social life), feelings of deviance, and lack of social support from every source in the engineering environment. These correlations suggest that absence of social support is a more important influence on the decision to drop out than is indicated by the responses to the open-ended questions.

The factor interrelationships shown again in Figure 4.1 confirmed the influence of both grades and social support on satisfaction. The figure shows the factors most related to satisfaction were the absence of support and approval from the family, the perception of a less favorable social life, and feelings of social ambiguity and isolation.

The two environmental sources of support--from a confidant and from the faculty/administration--also had a strong relationship to satisfaction. The importance of the environmental sources of support was confirmed by a discriminant analysis run on the composite scores of support and different measures of satisfaction (Appendix A). The analysis showed that the only source of support that consistently discriminated between dropouts and current attendees was the support from male peers in engineering, although school personnel were also important. Support from other women was not a significant factor in any of the analyses.

The same factors affecting satisfaction with engineering were those affecting performance, but in slightly different proportion; these included support from the family, a confidant, the institution, and per-

TABLE 4.1. CORRELATIONS WITH SATISFACTION IN ENGINEERING*

	Have Dropped Out of Engineering	Intend to Drop Engineering	Would Choose Engineering Again	Engineering Lived Up to Expectations	Would Advise Female Friend to Go to Engineering School
Intend to drop engineering	.70				
Would choose engineering again	.55	.54			
Engineering measured up to expectations		.21	.28		
Would advise female to go into engineering		.17	.34	.36	
Actual grade point average	-.19	-.18	-.24		
Social life what expected			.15		
Social life better in another major			-.24	-.18	-.20
Had closer friends before engineering			-.18		
Spent more time with friends before engineering				-.17	
Presence of a confidant			-.19		
Frequency of personal interaction on campus				.21	
Not knowing what people expect		.15	.21	.15	.23
Feeling different			.16		.25
Feeling unfeminine					.16
People expected different things of women engineers					.25
Not getting invited out			.17		
Lack of real friends			.22		
Nobody approves of what I'm trying to achieve			.15		
Frequency of problems	-.16	-.26	-.21		
Help available at school					.16
Social support from female friends		.19			
Social support from male friends	-.17**	-.25	.15	.19**	**
Social support from professors	-.17	-.17	.16	.18**	.24**
Social support from other school personnel				.17**	.21**
Difference between expected and actual GPA	.18	-.18	.21		

*p > .01 = .148.

**Significant discriminators between persistors and dropouts.

TABLE 4.2. REASONS GIVEN FOR CHANGING MAJORS*

Reason	%
Didn't like engineering/material covered	38
Transferred to other major	20
Failed a test/academic difficulties	12
Too difficult	8
Too much pressure	8
Personal reasons	4
Attitudes of other students	4
Unsure of abilities	4
Engineering college didn't offer preferred major	4

*Open-ended questions.

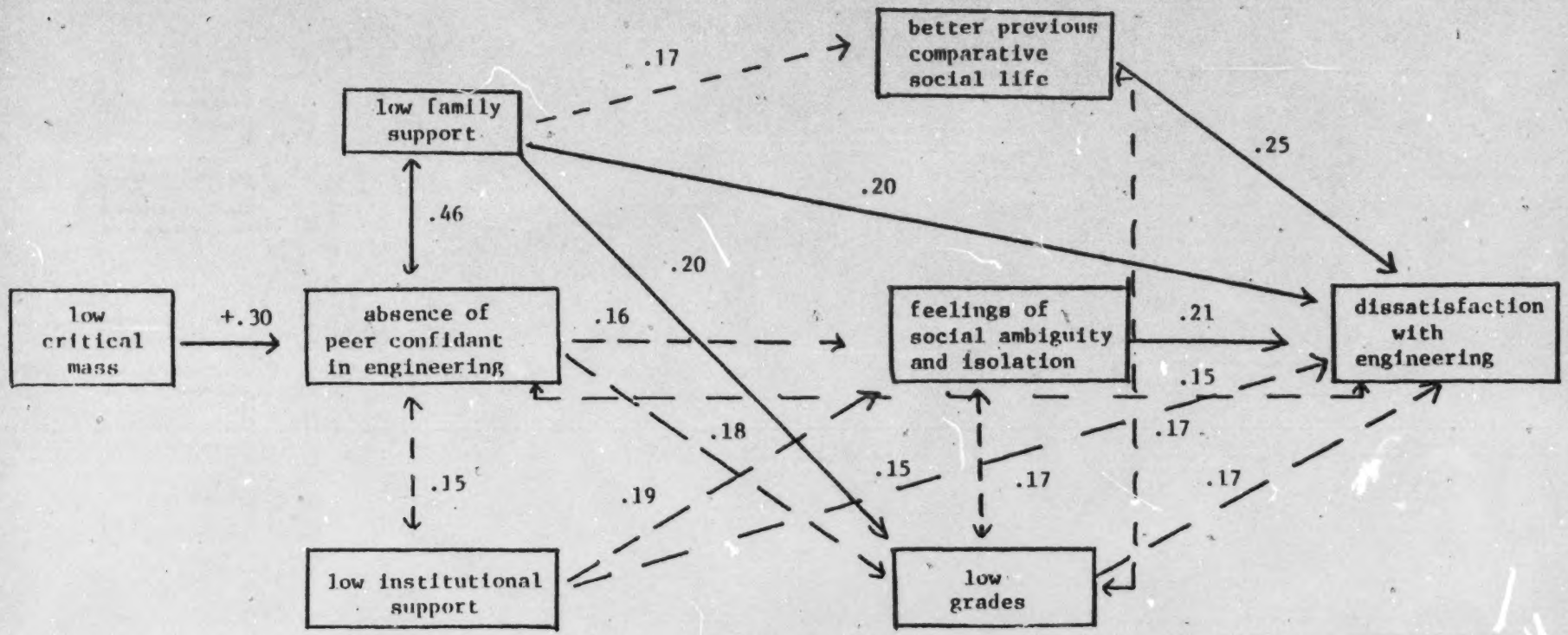


Figure 4.1. Interrelation of Factors

ceptions of social ambiguity and isolation and of better social alternatives. The similarity of the social influences on satisfaction and performance indicated the interdependence of social and academic factors in the decision to drop out of school or change majors.

Factor analysis is a descriptive technique that cannot directly confirm hypotheses. However, the strong relationship of family support and previous or alternative social circumstances suggested that factors other than the support from the campus environment affect satisfaction. Nonetheless, the role of peer confidants and institutional support indicate that most satisfied female engineers are provided with some support from within the campus environment.

The evidence is somewhat mixed on the role of formal and informal group affiliations. In general, it appears that informal affiliations are more important to satisfaction, while formal affiliations were correlated with actual grade point average.

There was no direct and strong relationship between previous/comparative social life on feelings of social ambiguity and isolation. Contrary to the hypothesis of this study, it would appear that the absence of peer support is stressful irrespective of previous social activities.

The results, indicating the importance of both grades and on-campus sources of social support from male peers and faculty members, underscored the absence of any direct effects of critical mass. The presence (or absence) of a group of other female engineering students does not appear to influence satisfaction (possibly because there are still too few women), although the family had an unpredicted and strong impact. It seems that the dominant peers are more important and that support from minority populations cannot provide an adequate substitute. Congruence between the female student and the dominant environment, both academically and socially, is critical to satisfaction.

V. SOCIAL SUPPORT AND SOCIAL AMBIGUITY/ISOLATION

Synopsis

Social ambiguity/isolation is, in effect, role conflict. It is a situation common to many women in various nontraditional fields. Because of its importance, this study examined the factors and relationships of feelings of social ambiguity and isolation.

In this study, they occurred together: ambiguity/feeling unfeminine and isolation/feeling alone. Does the isolation create the ambiguity or the other way around?

Three major influences on these feelings were found: support from institutional personnel, a close friend/confidant/boyfriend, and grades. All occur within the school environment. One analysis showed that the presence of a boyfriend and the perceptions that the present social life was better than previous or alternative experiences affected feelings of isolation.

This study suggests that social ambiguity/isolation arise in part from the situation and environment and are related to the level of social support available to the student as well as her academic performance. In part, it may also be a question of personality--how well does the individual student interact with others and how skillful is she in obtaining support?

Background Information

Social deviance was measured by items such as "not knowing what's expected of me," feeling different, feeling unfeminine, and feeling that people expected different things from women engineers. In a word, it measured role conflict. Other items on the factor measured social isolation, such as feeling all alone, not getting invited out, and lacking real friends.

These items tapped what has, at least anecdotally, been presented as a major reason for lack of attraction to or attrition from nontraditional activities. The feelings of deviance, loneliness, and role ambiguity have often been discussed in the literature as confronting the young woman with both present and anticipated role conflicts regarding her future work and family aspirations. Because of the centrality of this issue to women in all nontraditional fields, an examination of the determinants and correlates of these feelings was conducted.

Results

The factor analysis repeated from Chapter 3, as Figure 5.1, indicated three major influences on feelings of social ambiguity and

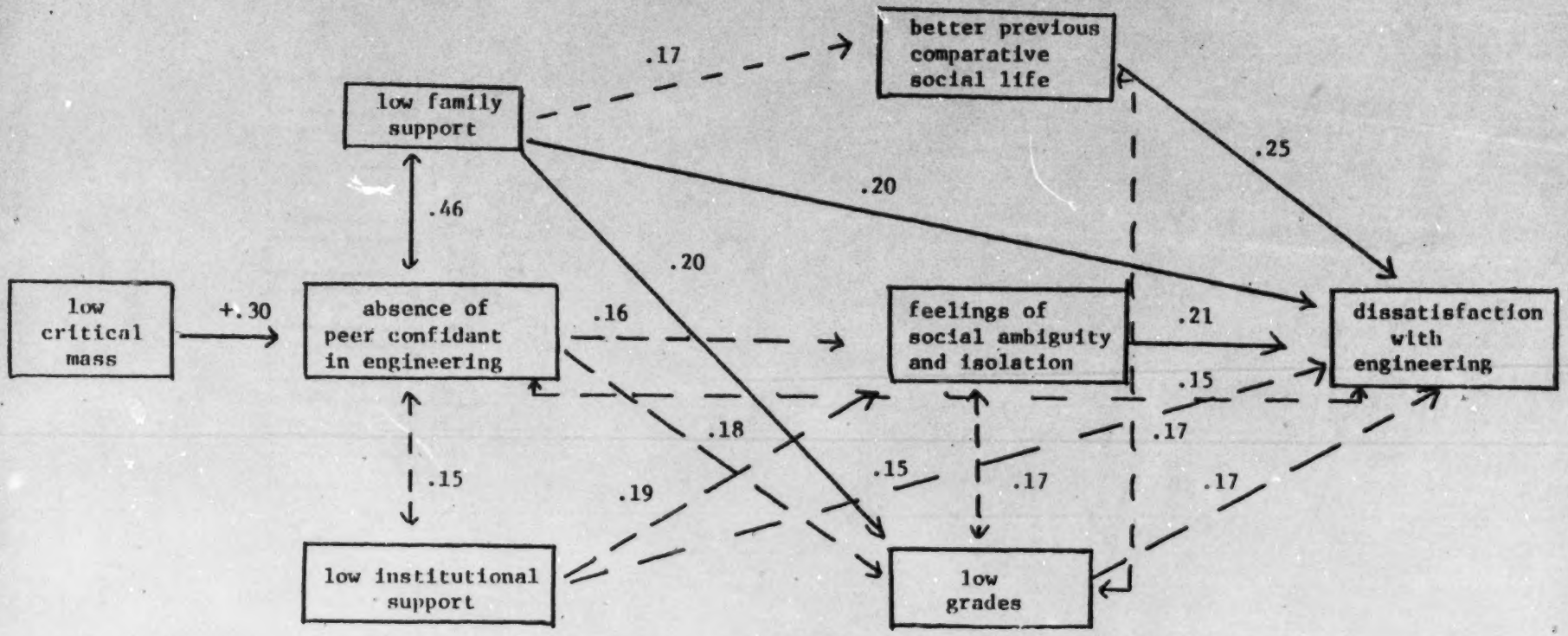


Figure 5.1. Interrelation of Factors

isolation. These were institutional support, frequency of interactions with a confidant, and grades. It is interesting to note that each of these is within the engineering school environment; family support seemed relatively independent of these perceptions.

Because of the interest in sources of support available to women scoring very high and very low on social ambiguity and isolation, a separate discriminant analysis was run using only these two groups and all sources of support. The only significant discriminators between the groups were the perception of support from a boyfriend and alternative social life.

These observations raise more questions about role conflict/social isolation than they answer. First, it is interesting that social ambiguity (feeling unfeminine) and social isolation (feeling all alone) occur together. Is it the feeling of isolation that creates the ambiguity, or does one avoid/not seek support when feeling deviant?

Second, the results regarding the perception of social ambiguity/isolation raise questions regarding its origin. On one hand, the relationship between social ambiguity/isolation and the support from institutional personnel, and a peer confidant indicated that the feelings result from real input from the environment and suggested that feelings of role conflict and concomitant social isolation are situationally induced perceptions. That is, social isolation is not an enduring personality trait of people unable to elicit support and encouragement from others. The absence of a relationship between social ambiguity/isolation and previous or alternative social situations lends credence to this hypothesis, as does the observation that current utilization and availability of social support are not different as a function of previous social life. These analyses indicated that perceptions of social isolation are a function of the dominant environment.

On the other hand, the generalization of perception of support by age and by environmental context suggested that the perception of social isolation is not only a function of the environment. Rather, the environment interacts with individual predispositions and social skills. The role of personality variables in obtaining support was substantiated by the close relationship between family support and the ability to discuss personal problems with a peer confidant. Additionally, the cluster analysis discussed in the next section suggested that a small number of women are able to elicit extraordinary support from all available sources.

The analysis indicated that the stress of ambiguity and isolation is compounded by, and cannot be separated from, stress arising from academic performance. The strong relationship between grades and feelings of social isolation and between grades and social support from a confidant and the family and alternative/previous social situations indicated the complexity of performance variables. Most notable in the relationship between social and performance variables was the presence of a relationship between institutional support and social isolation, but the absence of a relationship between institutional support and performance. In sum, performance appears to be strongly influenced by social variables.

VI. PATTERNS OF SUPPORT UTILIZATION

Synopsis

It is a mistake to assume that all members of a specific minority group in a nontraditional environment have the same needs, attitudes, or values. The sample engineering students surveyed for this study were not homogeneous.

Comments to the questionnaire indicated three types of female students: the pioneer, the prepared/socially sensitive, and the unprepared/socially sensitive. Each group has different types of academic and institutional problems.

In addition to these three types of students, analyses delineated five patterns of social support:

- *High on all supports;*
- *Average on most supports, high family;*
- *Average on most supports, low alternative social life;*
- *Average on most supports, high alternative social life;*
- *Average on most supports, high boyfriend.*

When it is finally acknowledged that members within a group are different, then it follows that their experience and the way the environment affects them are also different. But there is yet another difference that strongly affects a person's reactions to a situation and that is how he/she appraises the situation. For example, one female student in engineering may see the difficult, nonsupportive environment as a challenge; another student with the same background may feel the dominant males are out to make her look foolish and dumb.

Theories of tokenism, critical mass, and social support are too simplistic and narrow in their approach. Minority individuals in nontraditional environments are part of a complex social situation with constantly changing interactions and interrelationships. A theory is needed that takes into account not only the complexity of factors but the fluidity of change.

Background Information

Cluster analysis was performed for the purpose of identifying patterns of support utilization within the population, e.g., for types of people who use different patterns of support.

The concept of clustering groups of students was generated from the responses to open-ended questions on the survey. The comments indicated that female engineering students were not homogeneous in their attitudes and need for social support. The following observations were made from an examination of the respondents' comments.

Three fairly distinct types of female engineering students were identified from the survey respondents. These characterizations were drawn from reading each questionnaire, the additional comments attached by many, and/or the enclosed letters.

The first type of student could be classified as the "pioneer type." She is a very determined student who doesn't think any special problems exist for female engineering students and who resents being singled out or included in a group in need of any special programs or help. This group tends to value the friendship and support of male classmates more than female classmates.

The second type of student, labeled prepared, socially sensitive, is fairly self-sufficient and at least adequately prepared for the engineering curriculum but feels to some degree the stress of the large workload, lack of adequate free time, and resentment of lack of respect from professors or male classmates who are resisting the entrance of women into engineering. This group generally has fairly high grades in high school and finds it difficult to deal with a failing grade on a test or course or with having to work so hard to understand a concept unfamiliar to them. Indications are that students in this group are committed to engineering as a career but have had second thoughts about it.

The third type of student, unprepared, socially sensitive, can generally be characterized as being overly burdened by the workload and lack of free time; by being or feeling underprepared for the curriculum in terms of math, science, and/or drafting and mechanical skills; and by being very sensitive to the resentment or resistance she perceives from professors or male classmates.

The bulk of the institutional and peer support problems were mentioned by the third group of women, those who were academically underprepared and socially sensitive. Almost none were mentioned by the group of women who were "pioneers." Most of them felt as though they obtained equal if not special support from the institution. Students who felt unprepared cited difficulties with a great variety of situations, including many that were personal and not necessarily connected with school. Many, however, cited difficulties directly connected with the school, professors, counselors, and other students which they considered bad experiences. A fairly common issue involved professors and/or counselors. Students having grade problems would ask for help from a professor or counselor and instead of receiving help, they would receive a discourse on why they should not be in engineering or why they should transfer to a more traditional curriculum. A related issue commonly cited was that professors would single out the

women for the difficult questions or ridicule them in class for errors or "dumb" questions. It should be noted that some students also praised certain professors for their willingness to help and devotion to all students, although this was much less frequently cited.

Propositioning by professors or their assistants was also cited by a few students. Some felt their grades suffered due to their unwillingness, while others were sure they had gotten better grades than they deserved from professors intending to proposition them.

Also mentioned as an institutional problem was the lack of activities or programs that either included women or were for female students. The most frequently mentioned were sports programs or adequate availability of athletic facilities for the women.

Finally, in some cases, the few women that were in a class together often reported competing more with their female classmates than with their male classmates. Competition was due to each not wanting to be the "dumb girl in the class." This can be explained by the fact that women were so visible and few in numbers that the female students felt they had to be better than the other female students to be equal to the males.

Results

The results of a K-means method of clustering showed five clusters or patterns of support utilization. The five groups were: (1) high on all supports, (2) average on most supports but high family support, (3) average on most supports and low on alternative social life, (4) average on most supports and high on alternative social life, and (5) average on most supports but high on boyfriend. The only variable with strong power to predict cluster membership was support from boyfriend/spouse.

From the cluster analysis, several observations may be made. The first is that female engineering students are not a homogeneous group with distinct and identifiable needs for or utilization of social support systems. Rather, the vast majority received average support from various sources and are distinguishable on their perception of previous or alternative social circumstances. The exceptions to this are those women who have extremely high support from either a boyfriend or their families or who received a great deal of support from all sources, a small percentage in each case (see Appendix A for the numbers in each cluster).

The finding of a high support group(s) and an average majority is in contradiction to the findings of Gordon and Pipkin (1978). They found a bimodal distribution of perceived support--either very high or very low--with a 15:85 ratio of males to females. The present study included more dimensions of support and the analyses "collapsed" over some of these dimensions. Hence, it is possible that the groups having average social support may have been bimodally distributed on support obtained from any specific source.

Of theoretical interest is the large number of women who received an average amount of social support but who perceived receiving much more support before engineering school. The same pattern of current support availability (or lack of it) characterized those who had less auspicious previous social lives. This appears to suggest that for most people, social support may be a situational or contextual variable, although the small number who were high on all support variables may be extremely socially competent and able to obtain support in most environments. Specially, those institutional factors contributing to the perception of a less satisfying social environment should be examined more closely.

The hypotheses generated on the responses to the open-ended question were related to need for social support vis-a-vis their cognitive appraisal of the current environment and their individual characteristics. That is, the pioneers may have little perceived need for special supports because they appraise the situation as a challenge to which they are equal. The prepared/socially conscious probably have average needs, and the unprepared/socially conscious have a high need because of the academic stress they feel. The clusters relate more to utilization and perceived availability than to need or appraisal. Budget limitations did not allow an attempt to match the need/utilization patterns. The hypothsis may be made that distinct patterns of situation appraisal are related to the utilization of support groups. For example, the high need group (unprepared/socially conscious) score high on role ambiguity and social isolation and perceive less support from male peers or institutional personnel than the pioneers.

VII. DISCUSSION AND IMPLICATIONS

Synopsis

It is to the benefit of our society that the role of women is expanding. As this happens, there will be women moving into nontraditional areas. At first (and some of this continues), there were programs to "make women over to fit the new roles." These special programs may be counter-productive as they focus on women's "deficiencies." The theory of critical mass moved away from these negative concepts and said, "It's not the women's fault, it's the environment; just add more women and that will change." But this study indicates that only increasing the number of women in the environment may not be enough to initiate systematic institutional change.

This study found no relationship patterns between critical mass and perceived institutional support, feelings of social isolation and ambiguity, or satisfaction with engineering. Social support, however, is important and is necessary in order to avoid feelings of social isolation/ambiguity.

It is essential that women continue to be attracted to and retained in nontraditional fields. In order to do this, we must carefully examine the complex and fluid interaction of people and their environment. We cannot freeze a moment in time and learn only from that. Rather, we need a model that can accommodate an always changing flow of feedback and interplay which transforms perceptions and reactions. It is this that we must look at, as difficult a task as it may be, in order to provide information necessary to design interventions that meet the needs of all the individual women who choose to break away and form new paths.

Discussion

Although other researchers have found some of the predicted systematic effects of critical mass such as increased attraction, greater percentage of minority faculty (Connolly, 1979), and retention (Ott, 1978), these effects have been weak and not statistically significant. The present study failed to find any differences in perceptions as a function of the proportion of women in the school, but the different proportions were correctly perceived. Specifically, no differences in perceived institutional support, feelings of social isolation/ambiguity, or satisfaction with engineering were noted as a function of critical mass. All of the studies have suffered from serious methodological flaws, primarily the unavailability of sufficient and/or reliable data and restricted ranges and recency of increased enrollments. Nevertheless, the consistency of finding the small and/or indirect effects of critical mass suggests that critical mass (up to 20 percent) in and of itself will not provide a panacea from the problems of occupational/educational segregation, and sheer numbers will not necessarily generate system-wide changes.

While aggregation or critical mass may not be a sufficient condition for institutional change, it may be a necessary precondition. The numbers may be necessary, but other environmental/institutional changes must occur to alleviate the problems of social isolation, at least in the short run. The effects of tokenism and small numbers are more subtle, complex, and entrenched than can be eradicated merely by a rapid change in numbers.

Despite the failure to note significant institutional effects of critical mass, the primary assumptions of the theory--the effect of available social support within the environment and social ambiguity/isolation and satisfaction--were resoundingly confirmed.

Social isolation was definitely related to dissatisfaction. Better previous or comparative social life, the absence of a boyfriend or a peer confidant, and high institutional support all appear to be related to feelings of social ambiguity and isolation but were independent of the support received from family sources.

Significant relationships between the perceived support from school personnel and peer confidants were also related to satisfaction. Of particular interest was the relative unimportance of "generalized" female groups, suggesting that critical mass or aggregation theories are inappropriate because the dominant opinions and a close confidant are the most significant indicators of the perceived sense of belonging or "fit" of the women to the environment.

The study was not designed to distinguish among theories of critical mass, tokenism, social support, and individual-environment fit, but several observations about the findings may be made. Specifically, the study found that small changes (i.e., 5 percent females) make a difference in peer environment but not the institution. This finding does not substantiate critical mass assumptions. In fact, the pattern of findings of the importance of the dominant peer group, on grades, satisfaction, and feelings of isolation are most easily interpreted within the rubric of the congruence between the individual and her environment.

The present data, however, suggest several modifications to the current theories of the congruence between the person and the environment. First, contrary to previous findings suggesting the importance of a generalized peer group or of faculty contact, the present data indicate that the quality and intimacy of the relationship within the environment, not their numbers, determine integration. The present data also indicate the sources outside the immediate environment, such as the family, strongly influence decisions and support obtained from the environment.

Second, although entering characteristics have been shown in some studies to have minimal impact (e.g., Pascarella and Terenzini,

1979), interactional styles and social abilities most likely are an ongoing and important characteristic that determine the level of social integration in much the same way that academic ability influences grades.

Third, at least to some extent, there are compensatory functions or interchangeability among sources of support and avenues of activities that may provide feelings of integration, e.g., family, male or female confidants, institutional personnel. Fourth, at least in engineering schools, academic and social integration are not independent, but are closely tied. Although these two "types" of integration may be compensatory to a limited extent, they are likely more often accentuating, e.g., if academic integration is present, social integration is more likely.

Finally, the interrelationships between social and academic integration, and sources of social support suggest that linear models or causal models are inappropriate. Rather, many elements in the environment interact continuously, are reciprocal, and are transactional in nature. In sum, it seems that the individual-environment hypothesis are complemented and supplemented by the current work on social support.

If an individual-environment framework is used, the present research leaves many critical questions unanswered. Although no differences by school were observed on institutional support, satisfaction, isolation, or other major variables, the study does not provide sufficient information to determine the variables which increase the homogeneity between the individual and the environment. The study measured perceptions of social support and, to a lesser extent, expectancies and attitudes; it did not measure values, beliefs, and commitment/enjoyment of engineering, nor did it obtain individual measures of these characteristics on school entry. Further, the study only examined the environment as perceived by the female student and had no external validation of her perceived reality.* While subjective assessments of the environment provide the primary determinant of "fit," individual variations or individual differences in appraisal of the same reality should provide an increased understanding of the variables that control feelings of congruence and compatibility with the environment.

The study, while indicating the importance of peer support from the majority population, does little to illucidate why it is crucial. Does the support increase the amount of rewards derived from the system, or does it mitigate feelings of role conflict, or does it increase the ease with which one may perform the tasks at hand? These fundamental questions must be investigated to identify the most appropriate interventions that will increase the congruence between the individual and the environment.

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*With a single exception, the schools included in the study were schools judged by Connolly and Porter (1978) to be supportive of efforts to increase the number of women in engineering.

A hypothetical model of the findings illustrated in Figure 7.1 shows the lack of causality of any given factor and illustrates the bidirectional influence of perceived stress (need), situation appraisal (individual mode of response), task requirements, and social support on feelings of academic and social integration with the environment. The model also attempts to show a close relationship between the values and interest of the dominant majority and its effect on feelings of ambiguity and isolation, i.e., the inseparability of academic interests and social support. The similarity between this model and the directional/causal model proposed by Tinto (1975) may be seen by comparing Figure 7.1 with Tinto's model given in Figure 7.2.

Implications

Although strong institutional effects of critical mass were not observed, there is every reason to pursue policies of minority aggregation because the core assumptions of feelings of deviance and the role of social support were confirmed. However, either larger proportions and/or other supplementary interventions may be needed to initiate or accelerate systemic change.

Kanter (1977) has discussed some of the individual psychological responses of tokenism in terms of perceptual contrast, stereotyping, and assimilation and presents three main mechanisms for intervention. She describes two popular models of causality "of the absence of women in positions of power." The first is the individual model which argues that the cause is related to differences between men and women as individuals: their training for different worlds, the nature of sexual relationships, the tracks they were put on in school or in play, and even the "natural" disposition of the sexes. Kanter comments that repair programs for women who recognize their personal "deficiencies" offer a subtle and insidious system-maintaining message and confirm the old American notion that money and time are best spent making or altering the individual (p. 262). This model is the most typical intervention in engineering and may result in women feeling more visible, more deviant, and more isolated.

The equivalent of self-improvement programs for women is "self-examination" programs for men in which their sexism and ignorance about women are unmasked. Kanter feels this strategy, too, is doubtful as an effective change technique, even though some men undeniably gain insights into their behavior that can affect the ways they treat the women close to them. As a political tactic alone, questions can be raised. Such approaches are likely to arouse great resistance among men and antagonize those who may be allies (p. 263). Although few programs have been aimed at engineering males--either faculty or students--these too might result in an increased sense of deviance and incompatability by the female students.

Kanter concludes that an alternative model must be developed which assumes that individual responses are functions of organizational structure, such as the constraints imposed by roles and the effects of opportunity. This model would require that organizations--not people--must be the focus of change.

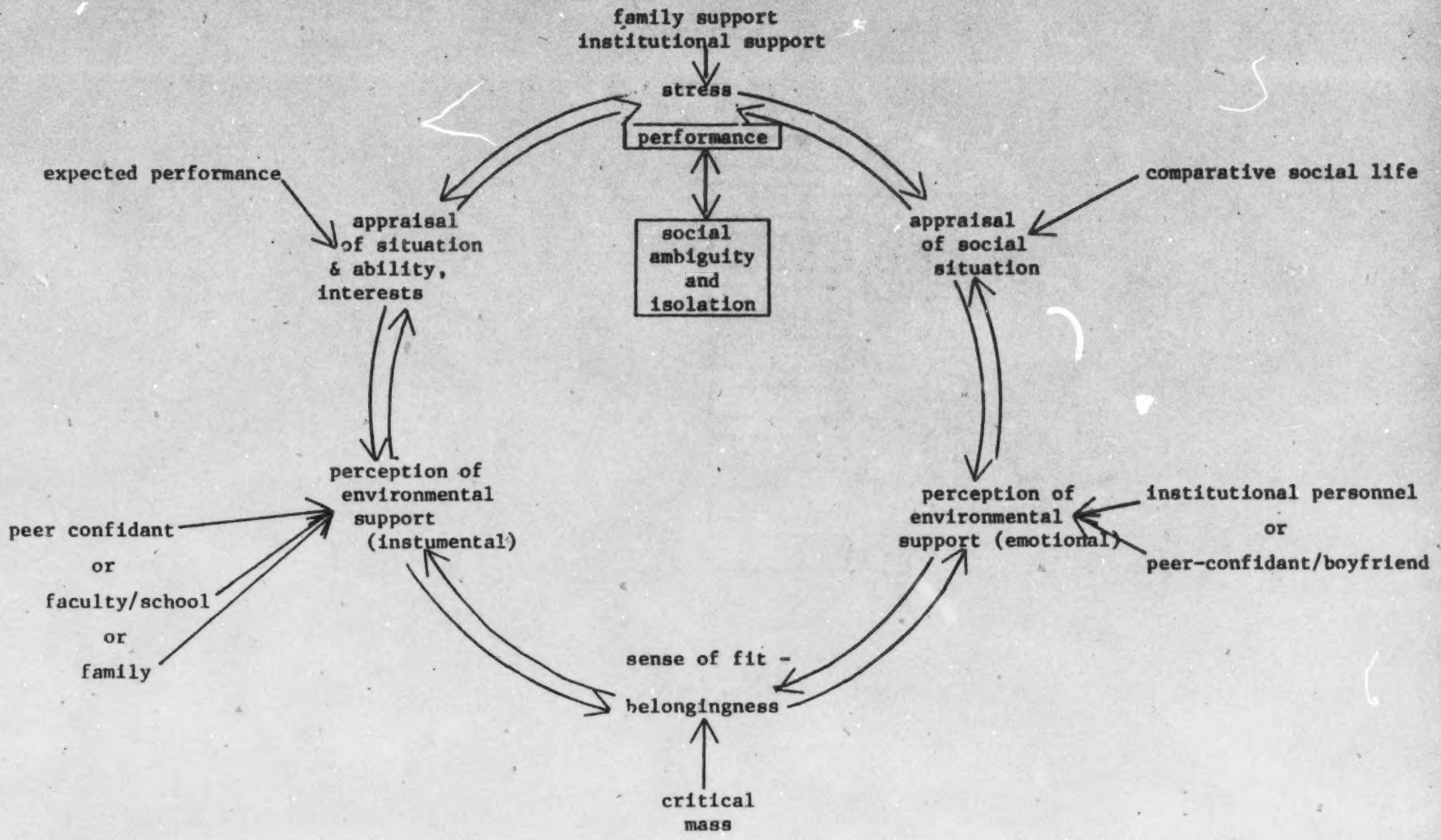

Figure 7.1. Role of Social Support in Person-Environment Fit

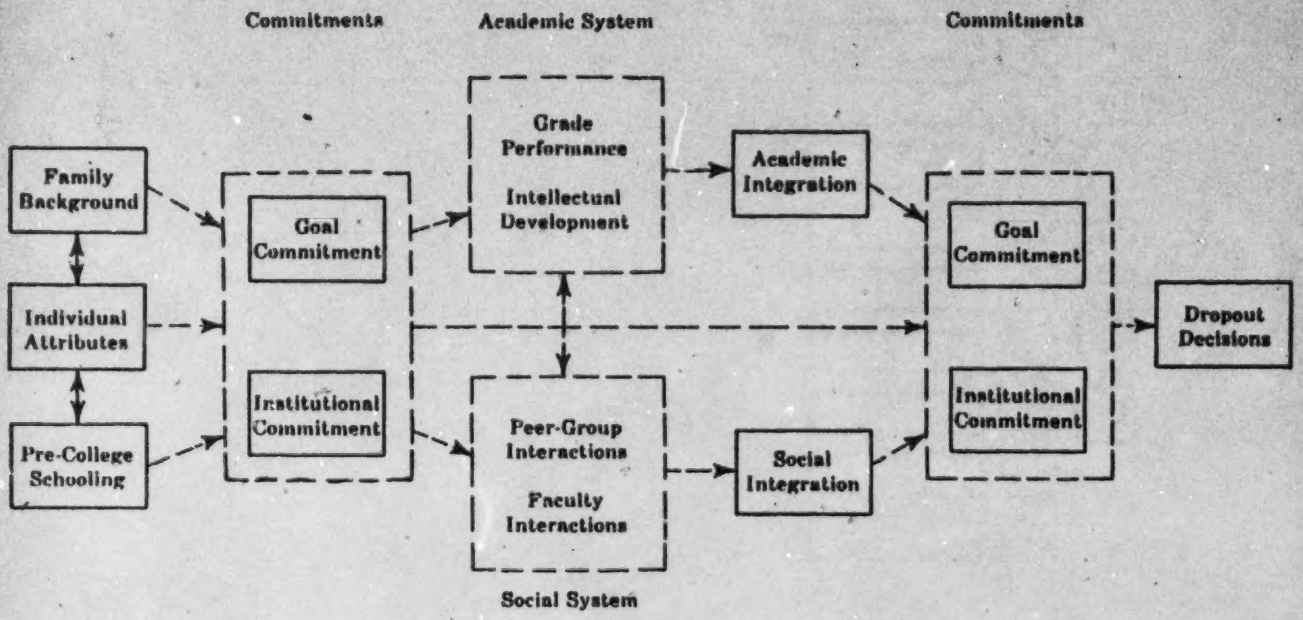

Figure 7.2. A Conceptual Schema for Dropout from College

The structural issues to which she alludes are those addressed from the theory of critical mass and its assumptions. Since the presence of numbers does not appear to alter the opportunities and power in the short run (and judging from the number of female-intensive occupations, such as education, which are controlled by men, it may not even change in the long run), it may be more fruitful to examine the assumptions of the "individual-environment" fit. Although similar, this theory may suggest more alternatives for interventions, e.g., a search for mechanisms to fit the person to the environment and a search to modify the environment to fit the person.

A loose interpretation of the current study suggests the following factors may be involved for those women not perceiving themselves as belonging in the environment:

- Feelings of less adequate academic preparation (not borne out by previous grades but may touch on experiential areas);
- Less focused or exclusive interest in engineering topics;
- Less perceived support from institutional personnel;
- Better previous/alternative social life;
- Absence of a boyfriend or confidant; and
- Absence of male peer group support.

The current study underscores the heterogeneity of women in engineering school with respect to dimensions, such as previous social life, need for support, appraisal of the situation as a challenge, and academic preparation, and suggests that no single intervention will be uniformly effective for all of these women. Further, some generalizations about engineering schools may be made, but each school has a different "character," and this character may be an important dimension in the perceived compatibility between the female student and the specific environment. No single intervention, then, may be equally effective or appropriate to different campuses. Administrators in engineering schools have commented on the general cohesiveness and self-contained nature of many engineering schools, which make it a tight social and academic environment that is intense and demanding, and necessitates close interaction with engineering associates in all aspects of the student's life. This atmosphere makes engineering a good example of the individual-environment fit hypothesis.

Designing interventions to change the environment to more closely "fit" the majority of women is more challenging, potentially more effective, and more innovative. One obvious need commented on by survey paricipants is the absence of athletic facilities and outlets. Given the broader academic interests of women (e.g., Davis, 1977), one institutional change that has received some current attention is the greater inclusion of liberal arts courses and activities on engineering campuses. The other

plausible alternative is the practice of housing the engineering school within a larger system. Our study, however, included both isolated and integrated engineering schools and found no difference between the two.

Until the dimensions that define feelings of incongruence and incompatibility (e.g., attitudes, values, aspirations, etc.) or the mechanisms (e.g., increments in reward, reduction of conflict, etc.) by which the feelings are reduced can be isolated, it is difficult to recommend specific interventions for nontraditional women. But the individual-environment fit hypothesis suggests some theoretical and practical questions that schools experiencing high attrition rates in any group(s) might ask themselves.

Previn (1968) describes a model which focuses on the way students as individuals and as groups perceive the environment. This research investigates the issue of student-college fit through the use of a semantic differential scale. Students rate themselves on concepts such as My College, Faculty, Administration, and Students on the same scales. Discrepancies between ratings on pairs of concepts are then related to reported probability of dropping out and various types of satisfaction with the college environment. Previn reports that students who perceived themselves as different from the college and other students generally reported a high probability of dropping out of college for nonacademic reasons. They also reported that they felt more out of place and were more dissatisfied with nonacademic aspects of life at their college. Furthermore, Self-Student discrepancies correlated best with dissatisfaction with students, Self-Faculty discrepancies best with dissatisfaction with faculty, and Self-Administration discrepancies best with disatisfaction with the administration. Discrepancy scores appear to relate better to the criterion variables than simple perceptions of self, students, faculty, administration, or college.

This method of specific inquiry might be used by schools to provide informative feedback not only regarding attrition problems but to point out organizational and administrative deficiencies.

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APPENDIX A

QUESTIONNAIRE FORM AND FREQUENCY OF RESPONSE

This questionnaire is about your social experiences in engineering school. If you are no longer in school, it is important that you answer the questions to the best of your memory. Please tell us what it was like when you were in engineering school.

1. Are you currently an engineering student?
   91% 9%
   a. yes. b. no.

2. If not, why did you drop out?

3. What is your current major? _____

4. Are you thinking about changing from engineering to another major?
   85% 11% 5%
   a. definitely no. b. maybe. c. definitely yes.

5. How many semesters of engineering school have you completed?_____

6. About what percentage of women are/were in your engineering class, (e.g., frosh, sophomore, junior, senior)?
   18% 36% 40% 5% 0
   a. 1%-5%. b. 5%-10%. c. 10%-20% d. 20%-30% e. more than 30%.

7. About what percentage of women are/were in most of your classes/lectures/labs?
   31% 35% 26% 7% 1%
   a. 1%-5%. b. 5%-10%. c. 10%-20%. d. 20%-30%. e. more than 30%.

8. About what percentage of women are/were in the entire engineering school?
   7% 33% 45% 11% 4%
   a. 1%-5%. b. 5%-10%. c. 10%-20%. d. 20%-30%. e. more than 30%.

9. About what percentage of all engineers are women?
   24% 43% 24% 6% 1%
   a. 1%-5%. b. 5%-10%. c. 10%-20%. d. 20%-30%. e. more than 30%.

10. Knowing what you know now, if you had to decide whether to go to engineering school, what would you decide?

    a. decide to go to engineering school. b. would have some second thoughts. c. decide definitely not to go into engineering.
    a. 71% b. 24% c. 5%

    Why did you answer as you did?

(Cont'd.)

11. In general, how well would you say that engineering school measures/measured up to what you expected?

54% 41% 5%
a. very much. b. somewhat. c. not very much.

12. If a good female friend of yours was interested in engineering, would you advise her to go to engineering school?

a. strongly recommend it. b. recommend it with reservations.
c. advise against it.
a. 58% b. 40% c. 1%

13. What overall grade point average do/did you expect to achieve? (A = 4)

14. What overall grade point average have/had you achieved? (A = 4)

15. In general, would you say that your social life at engineering school is/was about what you expected?

a. better. b. at least as good. c. about the same.
d. not as good.
a. 16% b. 25% c. 31% d. 27%

16. In general, would you say your social life at engineering school is/was as good as that of the other women there?

a. better. b. at least as good. c. about the same.
d. not as good.
a. 18% b. 32% c. 31% d. 19%

17. Do you think your social life would be/have been better if you were in another department or school?

a. better. b. at least as good. c. about the same.
d. not as good.
a. 31% b. 13% c. 48% d. 8%

18. Before you got to engineering school, did you have more friends than you do/did in engineering school?

15% 15% 34% 36%
a. more. b. at least as many. c. about the same. d. not as many.

19. Before you got to engineering school, were your friends closer to you than they are/were while in engineering school?

19% 11% 41% 29%
a. closer. b. at least as close. c. about the same. d. not as close.

20. Before you got to engineering school, did you spend more time with friends than you do/did when you were in engineering school?

a. spent more time. b. at least as much time. c. about the same.
d. not as much.
a. 40% b. 10% c. 20% d. 31%

(Cont'd.)

21. What campus organizations do/did you belong to?

$\bar{x}$ = 2.5 (number of organizations)

22. How many hours per week do/did you spend participating in these organizations? $\bar{x}$ = 6.2 hours a week

23. How many leisure hours do/did you spend each week with your male engineering classmates? $\bar{x}$ = 8.5 hours a week

24. How many leisure hours do/did you spend each week with your female engineering classmates? $\bar{x}$ = 7.9 hours a week

25. How often do/did you see your parents or nonengineering friends each month? $\bar{x}$ = 4.3 times a month

26. How often do/did you write or call your parents or nonengineering friends each month? $\bar{x}$ = 6.2 times a month

27. Is there anyone in particular you confide(d) in or talk(ed) to about yourself or your problems? a. yes. b. no.
95% 5%

A. Is/was this person in your engineering school? a. yes. b. no.
56% 44%

B. Is/was this person female? a. yes. b. no.
a. 59% b. 41%

C. What relationship does/did this person have to you?_____

28. In general, how much is/was this person like you?
19% 35% 37% 9%
a. very much. b. quite a bit. c. somewhat. d. not much.

29. How many people can/did you talk to about yourself or your problems?
1% 4% 14% 22% 16% 43%
a. none. b. one. c. two. d. three. e. four. f. more than four.

30. How many of the people that you can/could talk to about yourself or your problems are on campus?
7% 17% 24% 16% 9% 27%
a. none. b. one. c. two. d. three. e. four. f. more than four.

31. How often do/did you talk over your troubles or problems with someone?
22% 47% 30% 1%
a. very often. b. sometimes. c. not often. d. not at all.

32. How often do/did you talk about yourself or your problems to one of the people on campus?
27% 39% 26% 9%
a. very often. b. sometimes. c. not often. d. not at all.

33. Are/were you living on campus? a. yes. b. no.
61% 39%

(Cont'd.)

34. Who are/were you living with?

a. other engineering student(s). b. other nonengineering student(s). c. alone. d. family e. engineering and nonengineering students f. nonstudent(s) a. 26% b. 35% c. 8% d. 12% e. 18% f. 1%

35. Answer each of the following questions, for each person listed, using ratings from 1-4.

1 = very much
2 = some
3 = not much
4 = not at all

How much are/were each of these people	female friends in engineering	male friends in engineering	professors	other school personnel	boyfriend/spouse	other female friends	father	mother	other relatives
a. willing to listen to your problems?	1.7	1.8	2.4	2.7	1.2	1.5	1.6	1.3	2.1
b. helpful in getting your work done?. . . .	1.9	1.6	2.1	3.2	2.1	3.0	2.9	3.0	3.4
c. approving of your ambitions to be an engineer?.	1.2	1.5	1.7	1.9	1.3	1.5	1.2	1.2	1.5
d. helpful in boosting your spirits when you are feeling low? . . .	1.2	1.5	1.8	1.7	3.0	3.1	1.3	1.6	1.7
e. available to give you information, suggestions, or guidance?. .	2.0	1.9	1.0	2.5	1.7	2.1	1.7	1.7	2.4
f. caring about your welfare?	1.9	1.9	2.5	2.8	1.2	1.5	1.1	1.0	1.4
	1.65	1.70	1.9	2.4	1.75	2.10	1.63	1.63	2.08

Low score = high support

(Cont'd.)

36. How often are/were you bothered by the following in engineering school? Please check one response for each question.

	not at all	rarely	sometimes	rather often	nearly all the time	
a. feeling that school interferes with my social life.						3.1
b. not knowing what people expect of me. . .						2.7
c. feeling "different"						2.2
d. feeling "unfeminine".						1.6
e. feeling that people expect different things of women engineers						2.6
f. feeling all alone in the world.						2.0
g. not getting invited out by friends as much as I'd like.						2.1
h. lack of <u>real</u> friends.						1.9
i. feeling that nobody approves of what I'm trying to achieve						1.5

37. How often do/did you have problems that you could have used help with in engineering school?

26% a. often 51% b. sometimes 22% c. seldom 1% d. not at all

38. How often have/did you get help with problems at engineering school?

21% a. often 48% b. sometimes 26% c. seldom 5% d. not at all

39. How much help is/was available at school?

32% a. very much 51% b. some 17% c. not much 1% d. none

40. How important is your social life to you?

55% a. very much 38% b. some 6% c. not much 1% d. not at all

(Cont'd.)

CROSS TABULATIONS

The following cross tabulations were performed:

Response to Dependent Variable	Independent Variable	$p < (.05)$ Significant Results
Are you thinking about changing from engineering to another major?	Female Friends in Engineering, Male Friends in Engineering, Professors, Other School Personnel	Male Friends in Engineering
Would you decide again to go to engineering school?	Female Friends in Engineering, Male Friends in Engineering, Professors, Other School Personnel	Not significant
How will engineering school measure up to your expectations?	Female Friends in Engineering, Male Friends in Engineering, Professors, Other School Personnel	Male Friends in Engineering, Professors, Other School Personnel
Would you advise a female friend to go to engineering school?	Female Friends in Engineering, Male Friends in Engineering, Professors, Other School Personnel	Male Friends in Engineering, Other School Personnel, Professors
Perceived critical mass	Living on campus?	Increased mass perceived significantly higher if living off campus.
Perceived critical mass	School	Significant
Perceived critical mass	Who living with?	Not significant
Perceived critical mass	Female Friends in Engineering, Female Friends in Engineering (E), Female Friends in Engineering (I)	Not significant
Presence of confidant	Social ambiguity/isolation	Not significant
Is confidant female?	Social ambiguity/isolation	Not significant

INTERRELATIONSHIP OF FACTORS

Label	Deviant Status	Family Social Support	Frequency of Discussing Problems	Dis-satisfac-tion with Engineering	Better Comparative Social Life	Grades	Institu-tional Support	Critical Mass
1-Deviant Status	1.00	.19	.16	.21	---	-.17	---	---
2-Family Social Support		1.00	.46	.20	.17	-.20	---	---
3-Confidants in Engineering			1.00	---	---	-.18	.15	-.30
4-Satisfaction With Engineering				1.00	.25	-.17	.15	---
5-Comparative Social Life					1.00	-.22	.17	---
6-Grades						1.00		---
7-Institutional Support							1.00	---
8-Critical Mass								1.00

--- low correlation

DISCRIMINANT ANALYSIS

Dropped out of engineering

Male friends in engineering $x^2 = 23.5, p < .001$

Thinking of changing major

Engineering as expected

Male friends in engineering $x^2 = 24.82, p < .001$

Professors $x^2 = 12.44, p < .05$

Other school personnel $x^2 = 27.72, p < .001$

Advise friend to go into engineering

Male friends in engineering $x^2 = 18.36, p < .01$

Professors $x^2 = 18.23, p < .01$

Other school personnel $x^2 = 26.56, p < .001$

A final set of discriminant analyses were performed to aid in the interpretation of the cluster and factor analyses results. The results are shown below:

Discriminant Analysis

Grouping Variable	Discriminating Variables (Scales)	Significant Discriminators	Percent Correct classifications	P
Satisfaction	Family support, Institutional Support. Boyfriend Support, Peer Support, Previous Social Life	Peer	45.5	.000
Critical mass	Same	None	32.5	.004
Deviance/Role Ambiguity (high and low only)	Same	Boyfriend, Previous Social Life	61.8	.005

FACTOR ITEMS

Factor 1 - Social Ambiguity/Isolation
(High score is high ambiguity)

Feeling different	.58
Feeling unfeminine	.55
Feelong along	.53
Not getting invited out	.53
Feeling people expect different things of women engineers	.52
Nobody approves of what I'm trying to achieve	.45
Lack real friends	.41
Not knowing what people expect of me	.40

Factor 2 - Family Support
(High score is low support)

Father	.61
Mother	.60
Other relative	.53
Other school personnel	.41
Importance of social life	.34
Professor	.33

Factor 3 - Confidant in Engineering
(High score is few confidants)

Frequency of talking over personal problems with someone on campus	.74
Frequency of talking over personal problems	.50
Number confidants on campus	-.50
How many confidants	-.48

Factor 4 - Dissatisfaction with Engineering School
(High score is dissatisfaction)

Thinking of changing major	.79
Not currently in engineering	.72
Would not decide to go to engineering again	.57
Frequency of problems	-.26

Factor 5 - Better Comparative Social Life

More times friends before	-.48
Social life what you expected	.43
Closer friends before	-.38
More friends before	.37
School interferes with social life	.37
Social life better in another school/department	.35
Not getting invited out	.31
Lack real friends	.30

Factor 6 - Grades
(High score is high grades)

Actual GPA	.97
Expected GPA	.55
Difference between actual and expected grades	-.40

Factor 7 - Institutional Support
(High score is low support)

Professor	.61
Help available	.59
Other school personnel	.42
Often get help	.39

Factor 8 - Critical Mass
(High score is high percent)

Percent in class	.68
Percent in school	.65
Percent in labs	.57
Percent in profession	.41

CLUSTER ANALYSIS

Cluster analysis was performed for the purpose of identifying patterns of support utilization within the population survery, e.g., for types of people who use different patterns of support.

A cluster analysis employs any one of several popular algorithms to examine cases observed in multidimensional space, searching for patterns which define clusters of similar cases. The strict definition of a cluster is that the distance in multidimensional space between any two points in a cluster is smaller than the distance between the same points and their nearest neighbors outside the cluster. This strict definition of a cluster is often violated in social science work; nevertheless, it is a standard by which results can be usefully measured.

In our cluster work we employed two methods of clustering. Both methods were designed and programmed by David Huizinga and Tim Brennan of Behavioral Research Institute, Boulder, Colorado. The first method employed searches for naturally dense areas of the space by locating areas of monotonically increasing density. Points not lying in a dense region are denoted as outliers and are removed from consideration. Thus, in this method, clusters are defined only for dense points.

The second method employed was a k-mean algorithm, which partitions a set of cases into a preassigned number of clusters the end of an iterative procedure. In the end, each case belongs to the cluster whose center is closest to the case, and a-1 points are assigned to some cluster. This method implies a less vigorous standard for clustering because it will always assign a case somewhere. Thus, the algorithm may create clusters that are not dense or separated. In general, k-means clusters need to be carefully evaluated before they can be usefully interpreted. To evaluate the stability of the clusters obtained by the k-means algorithm, two different initial partitions are employed. If the same clusters are found using both partitions, the clusters are considered stable.

The clustering variables used were scales, formulated from the factor analysis. The scales, their reliability estimates (Kronbach's alpha) and the results of the first cluster method employed (the actual density method) are shown below.

Scale	α	Scale	α
Family Support	.815	Boyfriend Support	.979
Institutional Support	.830	Other Female Friend Support	.818
Peer Support	.774	Previous Social Life	.546

Variables with Strongest Power as Predictors: 4,5,2

Description	Number of Cases	Cluster Homogeneity
Near mean at all points	241	.64
High on Boyfriend; Average elsewhere	12	.86
Not near cluster	113	-

Using the natural density method of clustering, two clusters were identified. The clusters were fairly homogeneous and dense, but they were not well separated in space. The main difference between the two clusters was the high level of support received from a boyfriend/ spouse in cluster two. The outliers were those cases not near any of the clusters and not near enough to each other to form a cluster. They may have received a high level of support from any one source, but the patterns are not consistent.

Description	Members	Cluster Homogeneity
Average, except high on family support	71	.28
High on all supports except boyfriend, slightly above average there	11	-1.9
Average, low on previous social life	108	.69
Average, high on previous social life	132	.69
Average on family institutional, previous social life, other female friends. High on boyfriend. Slightly high on institutional	45	.23

Variable with strongest power as predictors of membership: 4

The results of the k-means clustering are shown above. Here, some clusters are not compact and the boundaries are close; thus, they are poor clusters according to the stringent definition of a cluster, but each was replicated by differences in the initial partition. Nevertheless, they are useful for providing a picture of the data. Several interesting aspects of the population are revealed here. As we can see by comparing clusters three and four, previous social life was

not related to current pattern of social support utilization. (Not that many of the results of the clustering are consistent with our observations from the factor analysis: the factor previous social life was unrelated to any other factor.) The basic difference which we found in the first clustering was brought out again here: that of boyfriend support. Despite the emergence of clusters one and two in the k-means method, the only variable with strong power as a predictor of cluster membership was variable four, the boyfriend/spouse support measure.

APPENDIX B

UNIVERSITY OF DENVER
An Independent University
University Park, Denver, Colorado 80208

Denver Research Institute
Social Systems Research and Evaluation

MEMORANDUM

To: Sue Klein, Leila Rosen Young
From: Alma Lantz, Linda Elliott
Date: 3/6/79
Subject: Unavailability of retention data

The Directory of College/University Programs for Women in Engineering lists the percentage of women in the total school, and the percentage in the freshman class, and the person responsible for women's programs at 289 schools.* We had originally planned to contact the listed schools to obtain the enrollment and attrition figures of women and minorities in their programs for the last four years, and to conduct a regression analysis on the secondary data.

To determine the kinds of retention data generally available from these colleges and universities and the different formats in which it is kept, DRI undertook an informal survey of selected institutions by telephone.

Many medium to large size institutions were contacted and asked what kinds of retention data they kept. A few schools, all successful at recruiting women, did have retention rates for women.** Most of these institutions did not, however, have the data in a useable form; those that did keep retention data kept it for the department or school as a whole and were not able to determine the retention rate specific to women. One institution had retention data specific for minorities but not for women.

The dean of engineering of one school contacted mentioned that he had just received a letter from John Alden of the Engineer's Joint Council seeking the same information. Since the Engineer's Joint Council was conducting a very broad national survey on retention rates,

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*The validity of the data in this document has subsequently been criticized.

**The estimated number keeping the data is about ten.

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John Alden was contacted to see if he had obtained any promising results. After talking with John we found that the results of his survey also showed that retention data specific to women was uniformly unavailable.

The Engineer's Joint Council annually publishes a Roster of Women and Minority Engineering and Technology Students. This roster, however, lists only those women and minority students from 158 schools reported to be within two years of graduation. In addition, most schools do have a listing of demographics on entering freshmen. Even if the junior and senior rosters were compared against the freshman roster, there would be no way to determine the circumstances of those students who did not appear on both rosters. In other words, we would have no way of verifying if the student dropped out, had transferred into engineering, or transferred in the same discipline to another school, or transferred to another discipline. Consequently, we are attempting to obtain primary data, using the freshman class rosters.

Our present efforts at obtaining information on the retention of women in engineering have been met with unexpected interest on the part of the institutions contacted.

Of the institutions contacted, all have enthusiastically agreed to assist us in surveying their students on factors contributing to retention and attrition of female engineering students. Several even went beyond what was requested by sending letters detailing their interest and willingness to participate. Two groups of schools are being asked to cooperate in this survey, those who have been successful in recruiting and retaining women and those who have been less successful. To date we have not encountered any school unwilling to assist us, even among the less successful schools. This is convincing evidence of the current interest among engineering educators in the problem of retention of female engineering students.

Given the importance of attrition data for internal administration of programs, and for research and documentation, a universal method of maintaining these records for easy retrieval appears necessary. One such method is suggested below. As part of our study, we will be asking the deans cooperating in our survey to review this suggested record keeping system in terms of compatibility with their present record keeping system and supplying the necessary information relevant to the retention problem.

An ideal system for tracking students who have left a school would be conducting an exit interview with each departing student to determine reasons for leaving, plans upon departure, etc. An historical file could then be kept relevant to the school's retention

rate and problems. However, it is not realistic to expect that this will be possible at every school or with every student.

A less cumbersome system of compiling attrition figures would be to calculate the number of enrolled students according to a few critical variables upon entry and at each registration period. This system would satisfy the need of schools to have up-to-date information on attrition. During each registration period, gross numbers could be compiled on the critical variables (sex, ethnicity, major, and class). At each successive registration, the compilation could be compared with the one immediately preceding it to determine the difference in the number in males, females, blacks, engineering students, etc. This would allow the school to determine the attrition rate specific to females, minorities or specific disciplines and to tailor their retention programs accordingly.*

Another more complicated system would allow analysis of individual student characteristics, as well as facilitate the compilation of data for regional and national research. Input to this system would also be done at each registration period, with each student identified by certain key variables. These variables would include student number, year entered, sex, ethnicity, age, GPA, and major. (The "major" variable could be coded in such a way to show any change in major since last registration.) This compilation by student could be run against the previous year's or previous registration period's compilation for a specific breakdown on those students no longer enrolled. Those students who had been enrolled and did not show up on a compilation could be determined to have dropped out or transferred. If exit interviews had been conducted, the individual files detailing reasons for dropping out could be identified and studied.

If kept and maintained on computer, this system would place minimal burden on the record keeping systems of an institution. If each student was required to complete a registration information card which contained the key variables required, these cards could be fed into the computer following each registration period. A file of students and key characteristics would then be available for attrition analysis.

Despite our initial problems with unavailability of data and redirection of the research, we are confident that we will be able to complete the work and report our findings by the September 30, 1979 end date. Should we encounter problems which would prevent our meeting this deadline we will notify NIE immediately.

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*Such a system has been computerized at some schools.

APPENDIX C

PARTICIPATING SCHOOLS AND STUDENT SAMPLES

School	Percentage of Women in School	Estimated Sample of Attendees	Estimated Sample of Dropouts	Total
Colorado School of Mines	14.0%	120	50	170
Carnegie-Mellon University	18.8	70	30	100
Lehigh University	12.8	202	35	237
Cornell University	12.5	70	50	120
Drexel University	8.0	20	10	30
University of Wisconsin-Milwaukee	8.5	70	30	100
University of Lowell	6.7	50	10	60
Texas Tech	7.0	50	50	100
Northeastern University	7.9	29	21	50
		681	286	967